70 SERIES MEASUREMENT SYSTEM

Modbus Manual



September 30, 2009
ML0025 Document Revision C

Bitronics ◆ D/3 ◆ Orion

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70 SERIES FIRMWARE VERSION

The following table provides the most recent firmware and software versions. For best results, the Configurator version used should match with the firmware version. A complete list of firmware and software versions is provided on the 70 Series Utilities CD.

Firmware Versions						
Description	Bios Version	DSP Firmware	Host Firmware	Configurator	Utilities CD	Release Date
M870 Family						
Mx7x Product Release, New Hardware supported Dual Bus, Analog I/O	2.1/3.0*	1.210	2.050	2.31	2.43	03/24/06
Mx7x Updated Release	2.1/3.0*	"	2.060	2.32	2.44	04/14/06
Mx7x Updated Release	2.1/3.0*	1.240	2.120	2.39	2.50	10/01/06
M87x Updated Release	2.1/3.0*	1.240	2.150	2.41	2.52	12/18/06
M87x Product Release, Fault Location, Adjustable Sample Rate	3.40	1.30	2.170	2.43	2.56	12/21/07
M87x Product Release; Add Demand per phase for Watts ,VAr, & VA. Configurator & Biview improvements w/ modems. Change to Digital I/O default watchdog contact (Configurator setup; not firmware dependent). Support new version of hardware on P3x, P4x modules.	3.40	1.30	2.18	3.00A	2.57	10/17/08
M87x Product Release: Added 1mHz accuracy on M87x. Improved poll rate from 500ms to 100ms for a single P40 transducer inputs module (M87x). Fault distance configuration is changed. Time sync with respect to DNP master is changed from the DNP master jamming the time to asking the master what time to jam. Increased waveform recording limit from 999 post trigger for longer recording.	3.40	1.31	2.19	3.02	2.58	09/30/2009
M87x Product Release, IEC61850 & SNTP; Avg 3-Ph Amps and Avg 3-Ph Volts	3.40	1.30	3.01.0	3.01	3.01	1/30/09

Firmware Versions						
Description	Bios Version	DSP Firmware	Host Firmware	Configurator	Utilities CD	Release Date
M87x Product Release: Added 1mHz accuracy on M87x. Improved poll rate from 500ms to 100ms for a single P40 transducer inputs module (M87x). Fault distance configuration is changed. Time sync with respect to DNP master is changed from the DNP master jamming the time to asking the master what time to jam. Increased waveform recording limit from 999 post trigger for longer recording.	3.40	1.31	3.02	3.02	3.02	09/30/2009

* H10/H11

70 SERIES MANUAL SET

ML0021 M87X User Manual
ML0032 M57X User Manual
ML0022 70 SERIES UCA® Object Model
ML0024 70 SERIES Modbus Plus Module & Protocol
ML0025 70 SERIES Modbus Protocol
ML0026 70 SERIES DNP3 Protocol
ML0027 M870D Remote Display Manual
ML0033 M570Dx Remote Display Manual
ML0034 70 Series IEC61850® Protocol Manual

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TRADEMARKS

SAFETY SECTION

Please refer to the M87x and M57x User Manuals, ML0021 and ML0032 respectively, for information regarding safety, installation, commissioning and decommissioning.

1.0 MODBUS INTERFACE

1.1 Description

The 70 Series IEDs support the Modbus protocol on two or three of the serial ports (P2 and P3 for M57x, P2-P4 on M87x). These ports can be configured for RS-232 or RS-485. All of these ports can be used simultaneously. Refer to the M87X or M57X User Manuals for hardware details.

The Modbus network is a "MASTER" to "SLAVE" network, that is to say, one node asks a question and a second node answers. A NODE is a Modbus device (PLC, Computer, M871, etc.) that is connected to the network. Each SLAVE NODE has an ADDRESS in the range of 1 to 247; it is this address that allows a MASTER to selectively request data from any other device. Address 0 is a BROADCAST ADDRESS that can be used with certain MODBUS functions to allow the MASTER to address all SLAVE NODES at one time. The 70 Series IEDs do not respond to BROADCAST messages.

The Modbus implementation in the 70 Series IEDs conforms to all standard Modbus specifications and capabilities, such as maximum nodes, distance, signal sensitivity, etc. The 70 Series IEDs are classified as SLAVE DEVICES in the Modbus structure. The data items that are available from the instrument can be obtained via the Modbus Network by issuing a READ HOLDING REGISTERS command from the requesting node.

1.2 Modbus Address

Ports 2 & 3 in the M57x or 2, 3, and 4 in the M87x can be set up to be RS-232 or RS-485 (P1 is RS-232 only, and does not support Modbus), and support baud rates up to 38400. Setting the address and configuring the Serial Ports can be accomplished by running the 70 Series Configurator. The default configuration for the serial ports is:

Serial Port Default Settings					
Port	Protocol	Parity	Baud	IED Address	Physical Media
P1	Zmodem/Display/Log	None	9600		RS-232
P2	DNP 3.0	None	9600	1	RS-232
P3	Modbus	Even	9600	1	RS-232
P4	Zmodem/Display/Log	None	9600		RS-232

1.3 Transaction Timing

The instrument completes a set of calculations approximately every cycle (16.67ms @60Hz) and calculations for volt and amp measurements every quarter cycle (4.167ms @60Hz). The HOST CPU processor service the Modbus ports by interrupts received from the corresponding serial ports. Incoming messages are parsed and responded to in approximately 2 ms.

1.4 Data Format

The 70 Series IEDs contain a set of holding registers (4XXXX) into which the instrument places values that correspond to the measurements the instrument is making. These holding registers can be read by any other device on the network using a READ HOLDING REGISTER (Function Code 3).

When using HOLDING REGISTER DATA, the Health Check Register should always be read and checked before interpreting data, since some failure modes will cause erroneous data to be presented (See Section 1.8). For conversion of the register data into ENGINEERING UNITS, please refer to Section 1.6. For specifics concerning the correct command and its implementation, users are directed to the M87X and M57x User Manuals for the specific device that will request the data. Listed in section 1.4.1 are the register assignments for the 70 SERIES IEDs when using the Configurable or Single Feeder Configurable (SFC) selection (used for M571 and M871). Appendix A provides the Legacy or Bitronics Legacy Fixed (BiLF) register set. NOTE: The 70 Series IEDs have a total of up to 6 different register sets (depending upon Configurator and firmware versions). A summary of the assignments for each of these six register sets is provided in Appendix B. Please refer to the 70 Series Configurator Modbus Register tab and click on the various options in the "Register Set" section to see register assignment details. For Configurator versions 2.27 or higher, the Register Sets on the left side of the box in the Modbus Register Screen are all fixed sets whereas the ones on the right side of the box are all configurable to varying degrees (some have a fixed portion followed by a section where the user can select any of the measurements available in the 70 Series IEDs). Note also that unless otherwise specified, all points are READ ONLY.

1.4.1 70 Series IEDs Modbus Register Assignments (Configurable/SFC (Single Feeder Configurable))

70 Series IEDs Modbus Register Assignments											
Code	**Modbus Address**	**Contents**	**Data**	**Scale**	**Ind**	**Values/Dependencies**	**Type**	**Min**	**Max**	**Step**	**Pass**
3	40001	Health 0	T1		Bit-0	DSP Gain Cal Error	Data	0-Norm	1-Fail	1	
					Bit-1	DSP Offset Cal Error					
					Bit-2	SIM Gain Cal Error					
					Bit-3	SIM Offset Cal Error					
					Bit-4	SIM Phase Cal error					
					Bit-5	SIM Ratio Csum Error					
					Bit-6	User Ratio Csum Error					
					Bit-7	User Gain Csum Error					
					Bit-8	User Phase Csum Error					
					Bit-9	DSP Board ID Csum Error					
					Bit-10	SIM Board ID Csum Error					
					Bit-11	User TDD Csum Error					
					Bit-12	DSP Integrity Csum Error					
					Bit-13	DSP Stack Overflow					
					Bit-14	CT\VT Scaling Error					
					Bit-15	Protocol Config Error					
3	40002	Health 1	T1		Bit-0	Reserved	Data	0-Norm	1-Fail	1	
					Bit-1	Reserved					
					Bit-2	Reserved					
					Bit-3	Reserved					
					Bit-4	Reserved					
					Bit-5	Reserved					
					Bit-6	Reserved					
					Bit-7	Reserved					
					Bit-8	Reserved					
					Bit-9	Reserved					
					Bit-10	Reserved					
					Bit-11	Reserved					
					Bit-12	Reserved					
					Bit-13	Reserved					
					Bit-14	Reserved					
					Bit-15	Reserved					
3	40003	Amps A	T2	Amp Scale			Data	0	32767	((1/32768) *10*Amp Scale) A	
3	40004	Amps B	T2	Amp Scale			Data	0	32767	((1/32768) *10*Amp Scale) A	
3	40005	Amps C	T2	Amp Scale			Data	0	32767	((1/32768) *10*Amp Scale) A	
3	40006	Amps N	T3	Amp Scale			Data	0	32767	((1/32768) *15*Amp Scale) A	
3	40007	Amps Residual	T3	Amp Scale			Data	0	32767	((1/32768) *15*Amp Scale) A	
3	40008	Volts A	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40009	Volts B	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40010	Volts C	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40011	Volts N	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40012	Volts AB	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40013	Volts BC	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40014	Volts CA	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40015	Volts A Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40016	Volts B Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40017	Volts C Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	

70 Series IEDs Modbus Register Assignments

Code	Modbus Address		Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Pass
3	40018		Volts N Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40019		Volts AB Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40020		Volts BC Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40021		Volts CA Bus2	T4	Volt Scale			Data	0	32767	((1/32768) *150*Volt Scale) V	
3	40022		Watts A	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *1500*Amp Scale * Volt Scale) W	
3	40023		Watts B	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *1500*Amp Scale * Volt Scale) W	
3	40024		Watts C	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *1500*Amp Scale * Volt Scale) W	
3	40025		Watts Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *4500*Amp Scale * Volt Scale) W	
3	40026		VARs A	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *1500*Amp Scale * Volt Scale) vars	
3	40027		VARs B	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *1500*Amp Scale * Volt Scale) vars	
3	40028		VARs C	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *1500*Amp Scale * Volt Scale) vars	
3	40029		VARs Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) *4500*Amp Scale * Volt Scale) vars	
3	40030		VAs A	T5	Amp Scale * Volt Scale			Data	0	32767	((1/32768) *1500*Amp Scale * Volt Scale) VAs	
3	40031		VAs B	T5	Amp Scale * Volt Scale			Data	0	32767	((1/32768) *1500*Amp Scale * Volt Scale) VAs	
3	40032		VAs C	T5	Amp Scale * Volt Scale			Data	0	32767	((1/32768) *1500*Amp Scale * Volt Scale) VAs	
3	40033		VAs Total Geometric	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) *4500*Amp Scale * Volt Scale) VAs	
3	40034		Power Factor A	T7				Data	-1000	1000	0.001	
3	40035		Power Factor B	T7				Data	-1000	1000	0.001	
3	40036		Power Factor C	T7				Data	-1000	1000	0.001	
3	40037		Power Factor Total Geometric	T7				Data	-1000	1000	0.001	
3	40038		Frequency Volts A	T8				Data	2000	8000	0.01 Hz	
3	40039		Frequency Volts B	T8				Data	2000	8000	0.01 Hz	
3	40040		Frequency Volts C	T8				Data	2000	8000	0.01 Hz	
3	40041		Frequency Volts A Bus2	T8				Data	2000	8000	0.01 Hz	
3	40042		Frequency Volts B Bus2	T8				Data	2000	8000	0.01 Hz	
3	40043		Frequency Volts C Bus2	T8				Data	2000	8000	0.01 Hz	
3	40044		System Frequency	T8				Data	2000	8000	0.01 Hz	
3	40045		Phase Angle Volts A Bus1-Bus2	T9				Data	-1800	1800	0.1 Degrees	
3	40046		Phase Angle Volts B Bus1-Bus2	T9				Data	-1800	1800	0.1 Degrees	
3	40047		Phase Angle Volts C Bus1-Bus2	T9				Data	-1800	1800	0.1 Degrees	
3	40048		Phase Angle Amps A Harmonic 1	T9				Data	-1800	1800	0.1 Degrees	
3	40049		Phase Angle Amps B Harmonic 1	T9				Data	-1800	1800	0.1 Degrees	
3	40050		Phase Angle Amps C Harmonic 1	T9				Data	-1800	1800	0.1 Degrees	
3	40051		Phase Angle Volts A Harmonic 1	T9				Data	-1800	1800	0.1 Degrees	
3	40052		Phase Angle Volts B Harmonic 1	T9				Data	-1800	1800	0.1 Degrees	
3	40053		Phase Angle Volts C Harmonic 1	T9				Data	-1800	1800	0.1 Degrees	

70 Series IEDs Modbus Register Assignments											
Code	**Modbus Address**	**Contents**	**Data**	**Scale**	**Ind**	**Values/Dependencies**	**Type**	**Min**	**Max**	**Step**	**Pass**
3,6,16	40054	VA/PF Calc. Type	T1		1	Arithmetic	Setting	1	4	1	
					2	Geometric					
					3	3 Element (L-N)					
					4	2 Element (L-L)					
3	40055	Meter Type	T1		402	70 Series Register Set	Data	402	400	0	
3,6,16	40056	Volt Scale Factor	T10				Setting	1000	9999	1	
3,6,16	40057	Volt Scale Factor Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40058	Amp Scale Factor	T10				Setting	1000	9999	1	
3,6,16	40059	Amp Scale Factor Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40060	Xfmr Ratio Volts A	T10				Setting	1000	9999	1	
3,6,16	40061	Xfmr Ratio Divisor Volts A	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40062	Xfmr Ratio Volts B	T10				Setting	1000	9999	1	
3,6,16	40063	Xfmr Ratio Divisor Volts B	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40064	Xfmr Ratio Volts C	T10				Setting	1000	9999	1	
3,6,16	40065	Xfmr Ratio Divisor Volts C	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40066	Xfmr Ratio Volts N	T10				Setting	1000	9999	1	
3,6,16	40067	Xfmr Ratio Divisor Volts N	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40068	Xfmr Ratio Volts A Bus2	T10				Setting	1000	9999	1	
3,6,16	40069	Xfmr Ratio Divisor Volts A Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40070	Xfmr Ratio Volts B Bus2	T10				Setting	1000	9999	1	
3,6,16	40071	Xfmr Ratio Divisor Volts B Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40072	Xfmr Ratio Volts C Bus2	T10				Setting	1000	9999	1	
3,6,16	40073	Xfmr Ratio Divisor Volts C Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40074	Xfmr Ratio Volts N Bus2	T10				Setting	1000	9999	1	
3,6,16	40075	Xfmr Ratio Divisor Volts N Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40076	Xfmr Ratio Amps A	T10				Setting	1000	9999	1	
3,6,16	40077	Xfmr Ratio Divisor Amps A	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40078	Xfmr Ratio Amps B	T10				Setting	1000	9999	1	
3,6,16	40079	Xfmr Ratio Divisor Amps B	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40080	Xfmr Ratio Amps C	T10				Setting	1000	9999	1	
3,6,16	40081	Xfmr Ratio Divisor Amps C	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40082	Xfmr Ratio Amps N	T10				Setting	1000	9999	1	
3,6,16	40083	Xfmr Ratio Divisor Amps N	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40084	User Gain Volts A	T12				Setting	-32768	32767	1/16384	
3,6,16	40085	User Gain Volts B	T12				Setting	-32768	32767	1/16384	
3,6,16	40086	User Gain Volts C	T12				Setting	-32768	32767	1/16384	
3,6,16	40087	User Gain Volts N	T12				Setting	-32768	32767	1/16384	
3,6,16	40088	User Gain Volts A Bus2	T12				Setting	-32768	32767	1/16384	
3,6,16	40089	User Gain Volts B Bus2	T12				Setting	-32768	32767	1/16384	
3,6,16	40090	User Gain Volts C Bus2	T12				Setting	-32768	32767	1/16384	
3,6,16	40091	User Gain Volts N Bus2	T12				Setting	-32768	32767	1/16384	
3,6,16	40092	User Gain Amps A	T12				Setting	-32768	32767	1/16384	
3,6,16	40093	User Gain Amps B	T12				Setting	-32768	32767	1/16384	
3,6,16	40094	User Gain Amps C	T12				Setting	-32768	32767	1/16384	
3,6,16	40095	User Gain Amps N	T12				Setting	-32768	32767	1/16384	
3,6,16	40096	User Phase Correction Volts A	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40097	User Phase Correction Volts B	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40098	User Phase Correction Volts C	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40099	User Phase Correction Volts N	T8				Setting	-18000	18000	0.01 Degrees	

70 Series IEDs Modbus Register Assignments												
Code	**Modbus Address**		**Contents**	**Data**	**Scale**	**Ind**	**Values/Dependencies**	**Type**	**Min**	**Max**	**Step**	**Pass**
3,6,16	40100		User Phase Correction Volts A Bus2	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40101		User Phase Correction Volts B Bus2	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40102		User Phase Correction Volts C Bus2	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40103		User Phase Correction Volts N Bus2	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40104		User Phase Correction Amps A	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40105		User Phase Correction Amps B	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40106		User Phase Correction Amps C	T8				Setting	-18000	18000	0.01 Degrees	
3,6,16	40107		User Phase Correction Amps N	T8				Setting	-18000	18000	0.01 Degrees	

1.4.2 Modbus Calculation-Type Codes

Type	Value / Bit Mask	Description
T1		Unsigned 16-Bit Integer
T2		Signed 16-Bit Integer - 2's Complement - Saturation 10
		Float Value = ((Integer Value) / 32768) * Scale * 10)
		Example: 5.0 A stored as 16384 when Amp Scale = 1:1
T3		Signed 16-Bit Integer - 2's Complement - Saturation 15
		Float Value = ((Integer Value) / 32768) * Scale * 15)
		Example: 150 A stored as 16384 when Amp Scale = 20:1
T4		Signed 16-Bit Integer - 2's Complement - Saturation 150
		Float Value = ((Integer Value) / 32768) * Scale * 150)
		Example: 119.998 V stored as 26214 when Volt Scale = 1:1
T5		Signed 16-Bit Integer - 2's Complement - Saturation 1500
		Float Value = ((Integer Value) / 32768) * Scale * 1500)
		Example: -750.0 W stored as -16384 when Volt Scale = 1:1, Amp Scale 1:1
T6		Signed 16-Bit Integer - 2's Complement - Saturation 4500
		Float Value = ((Integer Value) / 32768) * Scale * 4500)
		Example: -90.0 kW stored as -8192 when Volt Scale = 20:1, Amp Scale 4:1
T7		Signed 16-Bit Integer - 2's Complement - 3 Decimal Places
		Example: -12.345 stored as -12345
T8		Signed 16-Bit Integer - 2's Complement - 2 Decimal Places
		Example: 123.45 stored as 12345
T9		Signed 16-Bit Integer - 2's Complement -1 Decimal Place
		Example: -1234.5 stored as -12345
T10		Unsigned 16-Bit Integer - Normalized Ratio
		ratio = (Normalized Ratio / Ratio Divisor)
		Example : 1.234, 12.34, 123.4, and 1234 are all stored as 1234
T11		Unsigned 16-Bit Integer - Ratio Divisor
		ratio = (Normalized Ratio / Ratio Divisor); valid Ratio Divisors are 1,10,100,1000
		Example: X.XXX stored as 1000, XX.XX stored as 100, XXX.X stored as 10
T12		Signed 16-Bit - 2's Complement - Saturation 2
		Gain Value = Integer Value /16384)
		Example: -0.250 stored as -4096
T13		Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 10
		Float Value =((Integer Value - 2047) / (2048)) * Scale * 10
		Example: 5.0 A stored as 3071 when Amp Scale 1:1
T14		Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 150
		Float Value =((Integer Value - 2047) / (2048)) * Scale * 150
		Example: 119.97 V stored as 3685 when Volt Scale 1:1
T15		Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 1000
		Float Value =((Integer Value - 2047) / (2048)) * Scale * 1000
		Example: -500 W stored as 1023 when Volt Scale = 1:1, Amp Scale = 1:1
T16		Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 3000
		Float Value =((Integer Value - 2047) / (2048)) * Scale * 3000
		Example: 349.10 kW stored as 3040 when Volt Scale = 6:1, Amp Scale = 40:1
T17		Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 15
		Float Value =((Integer Value - 2047) / (2048)) * Scale * 15
		Example: 11.79 A stored as 2369 when Amp Scale 5:1
T18		Unsigned 16-Bit Integer - 12 Bit Offset Binary -1 Decimal Place
		Float Value = ((Integer Value - 2047) / (10))
		Example: 121.4 degrees stored as 3261
T19		Unsigned 16-Bit Integer - 12 Bit Offset Binary -3 Decimal Place
		Float Value = ((Integer Value - 2047) / (1000))
		Example: 0.978 Power Factor stored as 3025
T20		Unsigned 16-Bit Integer - Bit Control/Status
		0' - stored as zero; '1' - stored as 65536
T21		Unsigned 16-Bit Integer - 3 Decimal Places
		Example: 54.321 stored as 54321
T22		Bit
		Example: 1-bit is set, 0-bit is clear

1.5 Configuration

1.5.1 Setting CT and VT Ratios

The 70 Series IEDs are capable of internally storing and recalling CT and VT ratios. The CT and VT ratios are written to registers 40060 through 40083 over the Modbus communication port, and are stored in non-volatile memory on the CT/VT Module. Each ratio is stored in two registers, one for the Normalized Ratio and the other for the Ratio Divisor. Allowable constants for the normalized ratios are 1000 to 9999. The Ratio Divisors may be 1, 10, 100, or 1000 only. The number stored will be the high side rating of the CT Ratio or VT Ratio. Both a 500:5 ratio CT and a 100:1 CT will have a value of 100 stored. For example, to calculate a CT and VT ratio for Phase A from the data stored in the M871, use the following equation:

$$Phase\ A\ CT_{RATIO} = \frac{Phase\ A\ CT\ Value(40076)}{Phase\ A\ CT\ \ Ratio\ Divisor\ (40077)}$$

$$Phase\ A\ PT_{RATIO} = \frac{Phase\ A\ PT\ Value(40060)}{Phase\ A\ PT\ \ Ratio\ Divisor\ (40061)}$$

The 70 Series IEDs calculate all measured quantities in **PRIMARY UNITS**, unlike other Bitronics instruments (MultiComm and PowerPlex). The CT and VT ratio information (registers 40060 through 40083) is used to calculate these primary values. To force the 70 Series IED to report in secondary units, set the Scale Factor = to the CT or VT ratio, as appropriate.

Note: The Full Scale Integer Value of current and voltage reported by the 70 Series IEDs over Modbus can be changed, see Section 1.5.2.

In the event of a CT/VT Ratio Checksum Failure, the value in the Normalized CT Ratio and Normalized VT Ratio registers default to 1000, and the value in the CT Ratio Divisor and VT Ratio Divisor default to 1000. This results in a 1:1 CT Ratio and 1:1 VT Ratio.

> WARNING – TO PRESERVE SYSTEM PERFORMANCE, ONLY WRITE TO RATIO REGISTERS WHEN THE RATIOS NEED TO BE CHANGED.

1.5.2 Setting Current and Voltage Scale Factors

As detailed in Section 1.6, the data in the 70 Series IED Modbus registers is in NORMALIZED 2'S COMPLEMENT format. Measurements presented in this format do not have as much resolution as the 70 Series IED internal floating register values. Because of the wide dynamic range of the 70 Series IED inputs, the default full-scale integer representation of measurement values is a compromise that has been selected to accommodate typical system signal levels, while giving reasonable resolution. The maximum (or full scale) integer value that can be reported corresponds to some particular level of Amperes, Volts, Watts, etc.

The maximum full scale integer value of Amperes and Volts in the NORMALIZED 2'S COMPLEMENT format can be changed by means of the Current Scale Factor and Voltage Scale Factor ($I_{SCALE\ FACTOR}$ and $V_{SCALE\ FACTOR}$), which are modified by writing to the Normalized Scale Factor and Scale Factor Divisor (40056 to 40059) registers. *These*

Current Scale Factor and Voltage Scale Factor values are multipliers of the Default Full Scale values. To convert values reported in Modbus registers to engineering units, refer to Section 1.6. The default full-scale values for quantities are:

Quantity	Default Full Scale
Phase Current	10
Neutral Current	15
Voltages	150
Per-Phase Power (Watt, VAR, VA)	1500
Total Power (Watt, VAR, VA)	4500

$$I_{SCALE\ FACTOR} = \frac{Normalized\ Current\ Scale\ Factor\ (40058)}{Current\ Scale\ Factor\ Divisor\ (40059)}$$

$$V_{SCALE\ FACTOR} = \frac{Normalized\ Voltage\ Scale\ Factor\ (40056)}{Voltage\ Scale\ Factor\ Divisor\ (40057)}$$

The Current and Voltage Scale Factors are written to registers 40056 through 40059 and are stored in non-volatile memory on the 70 SERIES IED's Host CPU Board. Each Scale Factor is stored in two registers, one for the Normalized Scale Factor, and the other for the Scale Factor Divisor. Allowable constants for Normalized Scale Factors are 1000 to 9999. The Scale Factor Divisors may be 1, 10, 100, or 1000 only.

1.5.2a Scale Factor Voltage Measurement Example

For example, the default full-scale value of voltage (registers 40008 to 40021) is 150V, the default value of the Normalized Voltage Scale Factor (40056) is 1000, and the default value of the Voltage Scale Factor Divisor (40057) is 1000. Assume a system with a 1:1 VT Ratio. If it is desired to change the full-scale representation of volts to 300V (to accommodate a 208V input, for instance), change the value of the Normalized Voltage Scale Factor (40056) to 2000.

$$VOLTAGE\ Phase\ A - B = \frac{Value}{32768} \times 150 \times \frac{2000}{1000} = 300V$$

Note that since $V_{SCALE\ FACTOR} = 2$, the values represented by the power quantity registers will also be doubled.

Note that the full-scale representation of all the Voltage measurements will also change. The scaling for Power quantities cannot be set independently and will be the product of the Voltage and Current Scale Factors.

1.5.2b Scale Factor Current Measurement Example

Consider a system with a 2000:5 (400:1) CT, on which it is desired to measure the Phase A amperes. The Normalized CT Ratio (40060) would be set to 4000, the CT Ratio Divisor (40061) to 10. With the default settings for the Current Scale Factor, the maximum register value of "32767" would yield:

$$AMPEREs\,Phase\,A = \frac{Value(=32767)}{32768} \times 10 \times \frac{1000}{1000} = 10A$$

In other words, the integer value for Amperes would be at a maximum with only 10A flowing through the system primary conductors. To compensate for this, set the $I_{SCALE\ FACTOR}$ equal to the CT_{RATIO}. The Normalized Current Scale Factor (40058) would be set to 4000, and the Current Scale Factor Divisor (40059) to 10. If the maximum value of "32767" is returned in register 40003, it is converted to Amperes as follows:

$$AMPEREs\,Phase\,A = \frac{Value}{32768} \times 10 \times I_{SCALE\ FACTOR} = \frac{32767}{32768} \times 10 \times \frac{4000}{10} = 4000A$$

If it is known that the maximum current on the circuit is not this high, and it is desired to set the full scale representation to 1200A for added resolution, the Normalized Current Scale Factor (40058) could be set to 1200, and the Current Scale Factor Divisor (40059) to 10. The maximum value returned (32767) would then be equal to:

$$AMPEREs\,Phase\,A = \frac{Value(=32767)}{32768} \times 10 \times \frac{1200}{10} = 1200A$$

1.5.3 Resetting Energy and Demands and Triggering Recorders

The Energy and Demand registers can be RESET by writing a non-zero value to the appropriate Holding Registers. Writing a non-zero value to the Recorder Registers will trigger a waveform or disturbance record. All of these registers are user-defined, that is they are not part of the default 70 Series IED register set.

Reset / Trigger Functions
Reset Energy
Reset Demand Amps
Reset Demand Volts
Reset Demand Power
Reset Demand Harmonic
Trigger Waveform Recorder
Trigger Disturbance Recorder 1
Trigger Disturbance Recorder 2

1.5.4 Tag Register

The 70 Series IEDs provide a "TAG" register for user identification purposes. This register is a READ/WRITE register that allows the user to write a number from 1 to 65,535 in the tag register.

1.5.5 VA Calculation Type Register

The 70 Series IED can be configured to use one of several different methods to calculate Total VAs. Refer to the M87x User Manual for an explanation of the different calculation types. The VA Calculation Type register (40054) is a READ/WRITE register.

VA Calculation Type	Register Value

Arithmetic	1
Geometric	2
Equivalent 3-element (WYE)	3
Equivalent 2-element (DELTA)	4

1.6 Converting Data to Engineering Units

As was mentioned in Section 1.5, the majority of the data is stored in a Normalized 2's Complement format. When displaying these values at another location, it may be desirable to convert this format into engineering units. This conversion is readily accomplished using the following simple scaling equations:

BASIC EQUATION FOR NORMALIZED ANALOG INPUTS:

$$Engineering\ Units = \frac{Value}{32768} \times Default\ Full\ Scale_{SECONDARY} \times \frac{Normalized\ Scale\ Factor}{Scale\ Factor\ Divisor}$$

The **Value** referred to in the equations would be the value stored in the register that you wished to convert to engineering units. For example if you wanted to convert Phase A Amperes into engineering units, Value would be the value in 40003.

ENERGY is stored as 32-BIT values in static COUNTER registers. Energy values are in units of PRIMARY kWh or kVARh.

FREQUENCY is stored as a single binary value that is the actual frequency times 100.

POWER FACTOR is stored as the value times 1000. Negative power factors indicate that the VARs are positive. The sign of the Power Factor is the inversion of the Exclusive-OR of the Watts and VARs (i.e. if either the Watts or VARs are negative, then the Power Factor will be negative).

EQUATIONS for Fixed Data Register Set:

$$I_{SCALE\ FACTOR} = \frac{Normalized\ Current\ Scale\ Factor\ (40058)}{Current\ Scale\ Factor\ Divisor\ (40059)}$$

$$V_{SCALE\ FACTOR} = \frac{Normalized\ Voltage\ Scale\ Factor\ (40046)}{Voltage\ Scale\ Factor\ Divisor\ (40057)}$$

$$AMPEREs_{(Inst,\ Demand,\ Max)} = \frac{Value}{32768} \times 10 \times I_{SCALE\ FACTOR}$$

$$AMPEREs_{N\ (Inst,\ Demand,\ Max)} = \frac{Value}{32768} \times 15 \times I_{SCALE\ FACTOR}$$

$$VOLTs_{(Inst,\ Demand,\ Min,\ Max)} = \frac{Value}{32768} \times 150 \times V_{SCALE\ FACTOR}$$

$$WATTs(VARs)(VAs)_{TOTAL\ (Inst,\ Demand,\ Max,\ Max)} = \frac{Value}{32768} \times 4500 \times V_{SCALE\ FACTOR} \times I_{SCALE\ FACTOR}$$

$$WATTs(VARs)(VAs)_{PER\ PHASE\ (Inst)} = \frac{Value}{32768} \times 1500 \times V_{SCALE\ FACTOR} \times I_{SCALE\ FACTOR}$$

$$kWh\ (kVARh) = \left[Value_{HIGH\ WORD} \times 65536 \right] + Value_{LOW\ WORD}$$

$$FREQUENCY = \frac{Value}{100}$$

$$PF = \frac{Value}{1000} (-Lag, +Lead)$$

$$PHASE\ DIFFERENCE = \frac{Value}{10} (+Line\ Leading\ \mathrm{Ref})$$

All quantities reported in Primary Values. To force the 70 Series IED to report in secondary units, set the Scale Factor = to the CT or VT ratio, as appropriate.

The above equations provide answers in fundamental units (VOLTs, AMPs, WATTs, VARs, VAs and Hz). If the user desires other units such as KILOVOLTS, KILOWATTS or KILOVARS, the answers given by the equations should be divided by 1,000. If the user desires MEGAWATTS or MEGAVARS, the answers given by the equations should be divided by 1,000,000. Energy values are in units of kWh or kVARh.

1.7 Register Sets and Register Types

The 70 Series IEDs are shipped with a pre-defined set of registers and data types. These fixed registers do not change, but may be augmented by adding additional registers (and their data type) from the master listing. The List of Available Measurements may be found in the M87x User Manual. The 70 Series Configurator is required to modify the registers.

For users who wish to use a 70 Series IED on systems configured for other Bitronics products, a legacy register list may be selected. When selected, the legacy register list will be substituted for the 70 Series IED fixed registers. This legacy register list cannot be modified and will cause the 70 Series IED to emulate the response of a Bitronics

MultiComm or PowerPlex product. The Bitronics Legacy register list can be found in appendix A. To use the 70 Series IED with a Bitronics Analog Output Converter (AOC), model NAO8101 or NAO8102, it will be necessary to select the legacy registers.

1.7.1 Time Sync Registers

Pre-defined status registers are used to indicate the current state for each of the various time synchronization methods possible on the 70 Series IEDs. These registers appear in the Bitronics Advanced Fixed (BAF) and Harmonic Advance Fixed (HAF) register sets. The 70 Series Configurator allows the user to modify the configuration of time sync parameters.

The following time sync registers will return status values of '0' if a time sync master is inactive and '1' if a time sync master is active:
IRIG-B Time Sync, (UCA) Network Time Sync, SNTP Time Sync, DNP Time Sync.

1.7.2 Best Clock Source Register

The M87x or M57x determines the 'Best Clock Source' and returns a value to indicate the master that is synchronizing the time. This is based upon which time sync masters are active as determined from the Time Sync Registers and whatever time sync master takes priority.

Best Clock source	Value
IRIG-B:	**2**
(UCA) Network Time Sync	**3**
SNTP	**4**
DNP	**5**
Manual time set	**0**

Refer to the IED User Manuals (M87x or M57x) for additional information on Time Sync clock source priority.

1.8 Health Check

The 70 Series IED has several self-tests built in to ensure that the instrument is performing accurately. The results of these self-tests are available in the Health Check register (40001), which is a simple 16-bit binary value. Each bit represents the results of a particular self-test, with "0" indicating the test was passed, and "1" indicating the test was failed. The definitions of the various self-tests are described in the <u>M87x or M57x User Manuals</u>. The following table lists possible faults that would be detected by the self-tests, how the fault is indicated, the effects of the fault and any necessary corrective actions.

Self Test Bits				
Bit #	**Description**	**Hardware**	**Effect**	**Default Value**
0(LSB)	Factory gain calibration of Analog-Digital Signal Processor Module checksum error.	-A10 EEProm	Unit will continue to function using default values, at reduced accuracy.	A/D Gain = 1
1	Factory offset calibration of Analog-Digital Signal Processor Module checksum error.	-A10 EEProm	Unit will continue to function using default values, at reduced accuracy.	A/D Offset = 0
2	Factory gain calibration of Signal Input Module checksum error.	-S1x EEProm	Unit will continue to function using default values, at reduced accuracy.	CT/VT Gain = 1
3	Factory offset calibration of Signal Input Module checksum error.	-S1x EEProm	Unit will continue to function using default values, at reduced accuracy.	CT/VT Offset = 0
4	Factory phase calibration of Signal Input Module checksum error.	-S1x EEProm	Unit will continue to function using default values, at reduced accuracy.	CT/VT Phase = 0
5	Factory defined internal ratios of Signal Input Module checksum error. (Type of Signal Input Module)	-S1x EEProm	Unit will continue to function. Assumes -S10 Signal Input Module	Volts Ratio = 60 :1 Amps Ratio = 14.136 :1
6	User defined external transformer ratio checksum error.	-S1x EEProm	Unit will continue to function using default values (i.e. w/o user ratios).	User CT = 5:5, VT = 1:1
7	User gain correction values checksum error.	-S1x EEProm	Unit will continue to function using default values (i.e. w/o user gain).	User Gain = 1
8	User phase correction values checksum error.	-S1x EEProm	Unit will continue to function using default values (i.e. w/o user phase).	User Phase = 0
9	Factory defined board ID for Analog-Digital Signal Processor Module checksum error.	-A10 EEProm	Assumes default Analog-Digital Signal Processor Module.	Module -A10
10	Factory defined board ID for Signal Input Module checksum error.	-S1x EEProm	Assumes default Signal Input Module.	Module -S10
11	User defined denominators for TDD measurement checksum error.	-S1x EEProm	Assumes default TDD Denominator.	TDD Denom = 5A Secondary
12	DSP program integrity checksum error.	-A10 DSP Ram	Host trips watchdog, unit reboots.	
13	DSP stack overflow.	-A10 DSP Ram	Host trips watchdog, unit reboots.	
14	Invalid or missing Amp and/or Voltage Scale Factor	-H11 Flash File	Protocol will use default Scale Factor	Scale Factor = 1:1
15	Protocol configuration invalid	-H11 Flash File	M87x uses default protocol configuration	70 Series IED register set

1.9 Diagnostic Status LED

The Diagnostic LED is an indicator that shows the communications activity on the Modbus port on the 70 Series IED. The Diagnostic LED is a bi-color LED (red/green) indicator that is located on the Front Panel Board adjacent to each serial port. The Diagnostic LED will flash red every time the 70 Series IED receives data via the associated port and will flash green whenever the 70 Series IED sends data over the associated serial port. If the LED does not flash RED when a message is sent to it from a MASTER, check the network for the following problems:

1. Cable open or short circuit
2. Defective termination
3. Incorrect MODBUS ADDRESS
4. Incorrect polarity of cable connections

1.10 Heartbeat State Counter

The 70 Series IED provides a Heartbeat State Counter Register that allows the user to determine the time between successive polls. This counter will increment by the number of milliseconds that have elapsed since the last time the data was updated. Another use of this register is as a visual indicator that the data is changing; it allows users of certain MMIs to identify disruption in the polling of the instrument. The Heartbeat State Counter is a full 16-bit counter that rolls over at 65535 (65.535 seconds). The counter starts at zero on power-up, and is NOT stored in non-volatile memory.

1.11 Meter ID Register

70 Series IEDs provide a "Meter Type ID" register for model identification purposes (40055 for M87x default register set). This register is preprogrammed at the factory to be either 404 in M87x devices or 501 in M57x devices.

2.0 MODBUS PROTOCOL

2.1 Introduction

The MODBUS protocol is an open standard which defines a command-response method of communicating digital information between a master and slave device. The electrical connection between devices is known as a bus. In MODBUS, two types of devices attach to the bus, master and slave devices. A master device issues commands to slaves. A slave device, such as the 70 Series IED, issues responses to master commands that are addressed to them. Each bus must contain exactly one master and may contain as many slaves as the electrical standards permit.

All devices on a bus must operate according to the same electrical standards (i.e. all must be RS-232C or all must be RS-485). RS-232C standards specify that only two devices may be connected to a bus (i.e. only one slave is allowed). RS-485 specifications allow up to 32 devices (31 slaves) on a bus.

The MODBUS protocol specifications define two types of transmission modes: ASCII and RTU. This manual describes only the more common RTU mode. For more information, the manual "MODICON MODBUS PROTOCOL REFERENCE GUIDE" (PI-MBUS-300) may be purchased for a nominal fee directly from Modicon Inc.

2.2 MODBUS RTU Message Framing

Each message from either a master or slave consists of a continuous stream of characters. A silent interval of 3.5 character times (3.5 * 11 bits / 9600 baud = 3.5 millisecond), or more, separates these streams. Bitronics instruments implement this requirement by waiting for a 3.5 character time gap between characters. If the stream is valid and is addressed to this instrument, then the instrument responds as follows:

Enable the output interface drivers (RS-485 option only)
Wait TX Delay time (if configured)
Send the response as a continuous stream
Wait 3.5 character times
Disable the output interface drivers (RS-485 option only)

2.3 MODBUS RTU Message Content

The MODBUS RTU message stream consists of an address byte, a function code byte, a number of message bytes, and two check bytes. The address byte, which is in the range 1... 247, specifies the identity of the slave device. The function code byte in a master command indicates the operation that the slave is to perform. The function code byte in a slave response is the same value as the master command function code if no error occurs, otherwise it has 128 added to it. The message bytes in a command contain additional information needed to perform the command. Message bytes in a response contain the data requested if no error has occurred or a one-byte exception code upon errors. The check bytes are generated using the CRC-16 polynomial generator sequence (x16 + x15 + x2 + 1) with the remainder pre-initialized to all 1's. The most significant byte of the CRC is transmitted first.

2.4 MODBUS Function Codes

Bitronics instruments currently support the function codes shown in the following table. Note that the values are shown in hexadecimal (base 16). This table also shows the value that a slave would return upon an error.

MODBUS Function Codes			
Master Function Code	Slave Error Code	Name	Meaning
03_{16}	83_{16}	Read Holding Registers	Read values from transducer
06_{16}	86_{16}	Preset Single Register	Write ratio or reset energy/demand
10_{16}	90_{16}	Preset Multiple Registers	Write ratio or reset energy/demand

2.5 MODBUS Exception Codes

Bitronics instruments return exception codes back to the master upon certain conditions. All functions codes greater then 127 decimal ($7F_{16}$ or 0x7F) indicate a slave error response. The message byte indicates the exception code according to the following table:

MODBUS Exception Codes		
Code	Name	Meaning
1	Illegal Function	Master command contained an unrecognized function code.
2	Illegal Data Address	Starting address is illegal. Note that some registers are read-only and some are read/write.
3	Illegal Data Value	Either the register count is invalid or an attempt to write an illegal register value was found. Note that this code can be caused by attempting to read beyond the last instrument register.
4	Slave Device Failure	Instrument has failed. If problem persists, please consult customer service.

2.6 Supported MODBUS Commands

Bitronics instruments support one read and two write commands. All commands require a register address to be specified in the command. The first register, named 40001 is at hexadecimal address 0x0000. The energy/demand reset register, named 40100 is at hex address 0x0063. In commands and responses, the most significant byte of a two-byte value is transmitted first. All examples that follow use the hexadecimal values and an instrument address of 1.

2.6.1 Read Holding Registers (Function Code 03)

This function reads from 1 to 125 registers from the Bitronics instrument. The command requires a starting register and the number of registers to read. Attempting to read non-existent registers will cause an exception. Modbus read commands are limited to 125 registers maximum per read request, and some Modicon PLC Master Blocks (MSTR) are limited to 100 registers maximum per read request. The following example (M871 register set) shows two registers being read: Volts A (register 40008) and Volts B (40009).

COMMAND - Function Code 03 (Read Holding Registers)			
Byte	**Name**	**Example**	**Notes**
1	Slave Address	1	
2	Function code	3	
3	Start address high	0	Volts A at register 40008
4	Start address low	7	(40008-40001=07)
5	Register count high	0	
6	Register count low	2	Read 2 registers total
7	CRC-16 low	75	
8	CRC-16 high	CA	

RESPONSE - Function Code 03 (Read Holding Registers)			
Byte	**Name**	**Example**	**Notes**
1	Slave Address	1	
2	Function code	3	
3	Byte count	4	2 registers, 2 bytes each
4	Data high (40008)	66	Volts A = 6670 hex = 26224 decimal
5	Data low (40008)	70	
6	Data high (40009)	66	Volts B = 6650 hex = 26192 decimal
7	Data low (40009)	50	
8	CRC-16 low	CE	
9	CRC-16 high	FC	

2.6.2 Preset Single Register (Function Code 06)

This function writes to a single register. An attempt to write to a READ-ONLY register results in an exception response. The response to a valid (writeable) register command is an echo of the command. The following example shows setting of the VA calculation type (writing 2 to register 40054) command.

COMMAND and RESPONSE - Function Code 06 (Preset Single Register)			
Byte	**Name**	**Example**	**Notes**
1	Slave Address	1	
2	Function code	6	
3	Start address high	0	0035 hex = 53 decimal to specify register 40054
4	Start address low	53	
5	Data high	0	
6	Data low	02	0002 = 2 decimal
7	CRC-16 low	18	
8	CRC-16 high	05	

2.6.3 Preset Multiple Registers (Function Code 16)

This function writes one or more contiguous registers. An attempt to write to a READ-ONLY register results in an exception. The following example shows setting the Volt Scale Factor (40056) to 1000 and the Volt Scale Factor Divisor to 1000.

COMMAND - Function Code 16 (Preset Multiple Registers)			
Byte	**Name**	**Example**	**Notes**
1	Slave Address	1	
2	Function code	10	10 hex = 16 decimal
3	Start address high	0	0037 hex = 55 decimal to specify register 40056
4	Start address low	37	
5	Register count high	0	We write 2 registers (40056 and 40057)
6	Register count low	2	
7	Byte count	4	Two register, 4 bytes
8	Data high	3	Write 1000 to register 40056 : 03E8 = 1000 decimal
9	Data low	E8	
10	Data high	0	Write 100 to register 40057 : 0064 = 100 decimal
11	Data low	64	
12	CRC-16 low	30	
13	CRC-16 high	C6	

3.0 MODBUS OVER ETHERNET (TCP)

If the 70 Series IED is equipped with an Ethernet Module (-P10, -P11, or -P12, refer to the Operator's Manual), then it will respond to Modbus commands via TCP. The 70 Series IEDs can communicate with any device certified by Schneider Automation, Inc. for Modbus over Ethernet, as well as other devices. The 70 Series IED can simultaneously support Modbus, DNP3, and UCA2 protocols over the Ethernet link. The table below lists port assignments for all Ethernet based protocols supported by the 70 Series.

DNP	20000 (TCP, UDP)
	20, 21 (TCP)
Modbus	502 (TCP)
MMS (UCA & 61850)	102 (TCP)
SMTP (electronic mail)	25 (TCP)
	123 (UDP)
Telnet	23 (TCP)

The Modbus/TCP interface allows up to 63 simultaneous connections to the 70 Series IED. There are no configuration parameters. A TCP keep-alive timer ensures that connections close 2 hours after loss of contact with the 70 Series IED (also known as a "backhoe disconnect"). Any Unit_Id (including zero) will be accepted since there is only one device per IP address.

3.0.1 IP Addressing

The TCP/IP stack needs to be configured with an IP address, a SUBNET mask, and a ROUTER (GATEWAY) address. It is very important that the network have no duplicate IP addresses. Configuration of the address may be accomplished by using UCA, by running the 70 Series Configurator, or via a front panel serial port using a terminal emulator such as HyperTerminal™ or ProComm™

The units are pre-configured with an IP address / subnet mask/gateway address of:

192.168.0.254 / 255.255.255.0 / 192.168.0.1

4.0 MODBUS FILE TRANSFER

At the time this document was issued, a Modbus file transfer standard did not exist. Bitronics has created an internal standard that should ensure compatibility among all Bitronics products. This transfer protocol utilizes five upper pages of the 40000 Series Holding Registers to accomplish the file transfer. The 70 Series IED writes blocks of data into these registers and the Modbus master reads the blocks out of these pages and reconstructs the file.

The 40000 Series Holding Register pages are defined as follows:

Address	Function	Contents
FA00 to FAFA	Read 24 word	Read Header
FB00 to FBFA	Read N words	Read N words of file parameters
FC00 to FCFA	Read N words	Read N words of file parameters again
FD00 to FDFA	Read N words	Read N words of file data
FE00 to FEFA	Read N words	Read N words of file data again

The transfer protocol provides for three types of data transfer: the file header, the file parameters, and the file data. The transfer protocol also provides a means to re-read the last block of the file parameters and file data in case an error occurred during the transfer. The file header only contains 24 words and is not refreshed with new data after it has been read. If an error occurs reading the file header, the file header can simply be re-read. The file parameter and file header blocks are refreshed with the next block of data after they are read. If an error occurs while reading a block of the file parameter or file data, the data can be re-read by requesting the repeat page for the respective data type.

4.1 Specifications

The file header format and the **70 Series IED**'s header values are specified as follows:

Word	Parameter	70 Series IED Value
1	type of transfer	0
2-3	# bytes in parameter field	26
4-5	# bytes in data field	Size of file (in bytes)
7-8	product reference	Mx7x (4 ASCII bytes)
9	transmission product version	1
10-13	product serial number	00xxxxxx (8 ASCII bytes)
14	type of transfer (by product)	4 - .ZIP file (i.e. WVxxx.zip) 5 - Modbus file directory 6 - .DAT file (i.e. TR1.dat) 7 - .CFG file (i.e. TR1.cfg)
15-18	first element time tag	0 (format not supported)
19-24	reserved	0

The Bitronics Modbus standard does not specify a set of file parameters. According to the specification, the set of file parameters is used to decode the transmitted file at the application level. The 70 Series IED parameters are as follows:

Word	Parameter	Description
1	File number	Each file is assigned a unique file number
2-7	File name	DOS style file name
8-9	File size	Size of file (in bytes)
10	File date	MSB - month (1-12) LSB – day (1-31)
11	File year	Year (xxxx)
12	File time	MSB – hour (1-24) LSB – minute (0-59)
13	File status	0 – previously downloaded 1 – not yet downloaded

Note that the File Status only reflects the download status of the file with respect to Modbus masters (not whether the file was downloaded by other masters such as DNP, Zmodem, FTP, or UCA).

4.2 Bitronics Standard

The Bitronics Modbus standard specifies that the file transfer work as follows:

1) Modbus masters poll Modbus IEDs via a Fast Reading Byte (Modbus 07-Read Exception Status) command to determine whether a file is available for downloading. If the IED has a file available (not yet downloaded), the IED sets the associated bit in the Fast Reading Byte response.
2) Modbus masters detect the bit in the Fast Reading Byte response and read the File Header (address 0xFA00) from the Modbus IED.
3) The Modbus master determines the parameter field size and file data size from the data returned in the File Header.
4) The Modbus master reads the parameter field by requesting the appropriate number of blocks and bytes from the File Parameter page (address 0xFB00) of the Modbus IED.
5) The Modbus master then reads the file by requesting the appropriate number of blocks and bytes from the File Data page (address0xFD00) of the Modbus IED.
6) If an error occurs during the transfer of any of the blocks, the master can re-read the bad block by reading from addresses 0xFC00 and 0xFE00 (the repeat File Parameters and File Data pages).
7) After the Modbus master receives the last File Data block, the master sends a DO ACK (Modbus 05-Force Single Coil) command to the Modbus IED to acknowledge the transfer has been completed.
8) After receiving the DO ACK, the Modbus IED deletes the transferred file from its memory.

4.2.1 Bitronics Compatibility Mode

The 70 Series IED can be configured to operate in "Bitronics Compatibility Mode" in order to meet the Bitronics Modbus file transfer standard. The response procedure is outlined below.

1) The 70 Series IED will respond to the Fast Reading Byte (Modbus 07-Read Exception Status) command with bit 4 clear when no waveform capture files are available. The device will set bit 4 (b4 – Presence of a disturbance record not extracted) when a new record has been created.
2) The 70 Series IED will respond with the File Header data and open the new recorder file for reading.
3) The 70 Series IED prepares the first block (page) of both the parameter field and data field.
4) The 70 Series IED sends the File Parameters.
5) The 70 Series IED sends the File Data.
6) The 70 Series IED will re-send any requested blocks.
7) Since the 70 Series IED does not have coils, it will interpret any Modbus –05 Force Single Coil command as a DO ACK.
8) The 70 Series IED will respond to the DO ACK and will close and then delete the newly created record file.

The 70 Series IED is capable of communicating to various masters concurrently utilizing several protocols. The 70 Series IED is capable of storing Waveform, Disturbance and Trend recorder files. Some applications require that multiple masters have access to these files as well as other data generated by the 70 Series IED. To accommodate these numerous applications, the 70 Series IED's Modbus file transfer can be configured to operate in several different modes. The "Bitronics Compatibility Mode" previously described is just one such mode.

4.3 Basic File Transfer

The Modbus master MUST first read the File Header from the 70 Series IED prior to transferring a file. Reading the File Header serves two main purposes:

1) It informs the Modbus master of the size of the file to be transferred.
2) It requests that the 70 Series IED open the specified file.

If a file transfer is presently in progress on the specified 70 Series IED port, the device will respond with Modbus *Device Busy* response. If the file specified does not exist, the 70 Series IED will respond with the Modbus *Illegal Data Exception* response. If the specified file does exist, but the 70 Series IED cannot presently open the file, it will respond with the Modbus *Device Busy* response.

Next, the Modbus master has the option of reading the Parameter Header. The Parameter Header does not need to be read by the Modbus master. The Parameter Header does include information that the Modbus master may need.

The Modbus master then starts the actual file transfer. The Modbus master reads the required number of transfer blocks (determined from the file size) from the 70 Series IED. Each file transfer block contains up to 250 bytes of the file. The blocks are transferred

sequentially by reading Modbus address 0xFD00. After the 70 Series IED sends a block of data, it automatically increments to the next block of data. The 70 Series IED will re-send the last block of data when Modbus Address 0xFE00 is read.

Once the Modbus master has received the entire file, it is recommended that the master send a Modbus *Force Single Coil* command to acknowledge receipt of the file. When the 70 Series IED receives the *Force Single Coil* command, it will close the file. If the 70 Series IED does not receive a *Force Single Coil* command, the file will remain open until the configured timeout (*New Block Timeout*) expires.

Note:

1) The Modbus *Read Holding Register* command requests 16-bit registers. If the file size has an odd number of bytes, the extra byte sent is always zero. It is the Modbus master's responsibility to strip off the last byte before recreating the file.
2) Reading the File Header automatically opens that file on the respective 70 Series IED Modbus port. That file will remain open until either a file transfer acknowledge (*Force Single Coil*) command is received or the *New Block Timeout* expires. Only one file can be opened at a time on an 70 Series IED Modbus port.
3) Selecting the file to transfer is described later in this document.

4.4 File Transfer Configuration

The Modbus file transfer configuration consists of three parameters, the *Select File* Register, the *Delete File* Register, and the *New Block Timeout*. As previously mentioned, the 70 Series IED is capable of generating several different recorder files. The *Select File* Register setting permits the 70 Series IED to automatically select the oldest file for download or allows the user to manually select which file to download. The *Delete File* Register setting permits the 70 Series IED to automatically delete the file after it is sent or allows the user to manually select which file to delete. The *New Block Timeout* parameter specifies how long to wait after a file transfer stalls before closing the file and aborting the transfer.

4.4.1 Modbus File System

The 70 Series IED stores and generates several files that are accessible via Modbus. These files include recorder files and a Modbus directory, which contains a list of Modbus files. Upon power-up, the 70 Series IED assigns a unique file number to each Modbus file. The association between the Modbus file names and Modbus file numbers remains constant until the 70 Series IED is re-booted. The file numbers associated with the Modbus directory file and log files always remain constant.

4.4.2 Modbus Directory

The Modbus Directory (DIR) File is an ASCII text file that contains a list of all Modbus files along with their associated File Parameter information.

File#	File Name	File Size	File Date	File Time	File Status
0	DIR				
1	NEXTFILE				
2	TR1.CFG	7877	11-27-2001	16:14	0
3	TR2.DAT	7052	11-27-2001	16:14	0
4	WV001.ZIP	104,576	10-15-2001	08:10	0
5	WV002.ZIP	104,488	10-15-2001	15:09	0
6	WV003.ZIP	104,790	11-08-2001	06:19	0

The Modbus Directory always includes at least four files (File# 0 thru File# 3). These files include the DIR (the directory file itself), the NEXTFILE (automated), the TR1.CFG (Trend Recorder configuration) and the TR1.DAT (Trend Recorder data) file.

If there are additional files accessible via Modbus, they will appear after the four files listed above. These files will be Recorder ZIP files and have File Numbers greater than ‘3’.

4.4.3 Downloads

4.4.3a Manual File Select

When a Modbus master requests a File Header from the 70 Series IED, the device checks the File Number stored in the *Select File* Register and provides the File Header for the Modbus file with the matching File Number. As previously mentioned the File Number for each Modbus file can be determined by downloading and viewing the Modbus DIR file.

To manually select the file to download:

1) Write a ‘0’ to the *Select File* Register to select the DIR file.
2) Transfer the DIR file.
3) View the DIR and determine the File Number to download.
4) Write the File Number to the *Select File* Register.
5) Transfer the file.

4.4.3b Automatic File Select

The 70 Series IED reserves File Number ‘1’ as NEXTFILE in its Modbus directory. When a ‘1’ is written to the *Select File* Register, the 70 Series IED will automatically select the oldest file not yet transferred via Modbus. The 70 Series IED will only auto-select event type (Recorder) files. The Trend Recorder file is continuously changing and will never be auto-selected.

To have the 70 Series IED automatically select which file to download:

1) Write a ‘1’ to the *Select File* Register to select NEXTFILE.
2) Transfer the file.

If no new files exist and a Modbus master requests a File Header with NEXTFILE (‘1’) in the *Select File* Register, the 70 Series IED will return a File Header with the File Size set to 0. If a new file does exist, the 70 Series IED will return a File Header with the File Size set to the correct size of the file it selected. When the Parameter Header for the selected file is sent it will contain all of the correct parameters (File Name, File Number, etc.).

Modbus masters can determine new file availability by requesting a File Header with the *Select File* Register set to NEXTFILE (‘1’) and checking if the File Size is non-zero. This is not recommended since it simpler and faster to poll the Fast Reading Byte.

4.4.4 Deleting a File

4.4.4a Manual File Delete

The 70 Series IED allows Modbus masters to manually delete a file by writing the File Number to the *Delete File* Register.

To manually delete a file:

1) Write a ‘0’ to the *Select File* Register to select the DIR file.
2) Transfer the DIR file.
3) View the DIR file and determine the File Number of the file you wish to delete.
4) Write the File Number to the *Delete File* Register.

4.4.4b Automatic File Delete

The 70 Series IED can be configured to automatically delete a file after the file has been transferred to a Modbus master. To select auto-delete mode, either write the NEXTFILE File Number (‘1’) to the *Delete File* Register or use the 70 Series Configurator to initialize the *Delete File* Register to ‘1’. The 70 Series IED will not delete the transferred file until the Modbus master confirms the transfer with a DO ACK (Modbus 05-Force Single Coil) command.

4.5 File Transfer Configuration Modes

There are several configuration modes for 70 Series IED Modbus file transfers; all of these fall under two different levels of configuration: non-volatile “run-time” configuration, and volatile “on-the-fly” configuration.

The 70 Series IED has a selectable Modbus Register set. Not including the *Select File* Register and *Delete File* Register in the configured Modbus register set prevents Modbus masters from changing the file transfer mode. This would ensure that the 70 Series IED always operates in the same Modbus file transfer mode. The only way to change the Modbus file transfer mode would be to use the 70 Series Configurator and re-boot the device.

The *Select File* Register and *Delete File* Register can each be independently added to the configured Modbus register set. By including the *Select File* Register and not the *Delete File* Register, Modbus masters would have the capability of manually selecting files for transfer but could not delete files.

Both the *Select File* Register and *Delete File* Register mode settings are stored in non-volatile memory (via INI files). If the *Select File* Register and *Delete File* Register are accessible to Modbus masters, the Modbus masters can change the *Select File* Register and *Delete File* Register non-volatile settings. If the *Select File* Register and *Delete File* Register are not accessible to Modbus masters (not configured in Modbus register set), the non-volatile configuration can only be changed by the 70 Series Configurator program. Non-volatile storage of the *Select File* and *Delete File* Register ensures that the 70 Series IED always returns to the same Modbus file transfer mode after re-booting.

4.5.1 Bitronics Mode

In “Bitronics Mode”, new files are automatically selected for transfer and automatically deleted after the transfer is confirmed by the master. To configure the 70 Series IED to operate in Bitronics Mode, use the 70 Series Configurator to:

1) Set the *Select File* Register to ‘1’ (NEXTFILE).
2) Set the *Delete File* register to ‘1’ (NEXTFILE).
3) Make sure the *Select File* Register is NOT one of the configured Modbus registers.
4) Make sure that *Delete File* register is NOT one of the configured Modbus registers.

4.5.2 Bitronics Mode – Auto-Delete Disabled

This mode is identical to standard Bitronics Mode except that transferred files are not automatically deleted after they are transferred.

1) Set the *Select File* Register to ‘1’ (NEXTFILE).
2) Set the *Delete File* register to ‘0’
3) Make sure the *Select File* Register is NOT one of the configured Modbus registers.
4) Make sure that *Delete File* register is NOT one of the configured Modbus registers.

4.5.3 Manual File Transfer Mode – Delete Disabled

This mode allows Modbus masters to download a directory and manually select a file to transfer. Files can also be selected automatically by writing a ‘1’ (selecting NEXTFILE) to the Select File Register. Modbus masters cannot delete any files in this mode.

1) Set the *Select File* Register to ‘0’.
2) Set the *Delete File* register to ‘0.’
3) Make sure the *Select File* Register IS one of the configured Modbus registers.
4) Make sure that *Delete File* register is NOT one of the configured Modbus registers.

4.5.4 Manual File Transfer Mode – Automatic Delete

This mode allows Modbus masters to download a directory and manually select a file to transfer. Files can also be selected automatically by writing a ‘1’ (selecting NEXTFILE) to the Select File Register. The 70 Series IED will automatically delete files after the file is transferred and a confirmation has been received from the Modbus master. Modbus masters cannot manually delete files in this mode.

1) Set the *Select File* Register to ‘0’.
2) Set the *Delete File* register to ‘1.’
3) Make sure the *Select File* Register IS one of the configured Modbus registers.

4) Make sure that *Delete File* register is NOT one of the configured Modbus registers.

4.5.5 Manual File Transfer and Delete Mode

This mode allows Modbus masters to selectively transfer and delete all Modbus files.

1) Set the *Select File* Register to ‘0’.
2) Set the *Delete File* register to ‘0.’
3) Make sure the *Select File* Register IS one of the configured Modbus registers.
4) Make sure that *Delete File* register IS one of the configured Modbus registers.

APPENDIX A BITRONICS LEGACY MODBUS REGISTER ASSIGNMENTS

Bitronics Legacy Modbus Register Assignments											
Code	Modbus Address	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Pass
3	40001	Health 0	T1		Bit-0	DSP Gain Cal Error	Data	0-Norm	1-Fail	1	
					Bit-1	DSP Offset Cal Error					
					Bit-2	SIM Gain Cal Error					
					Bit-3	SIM Offset Cal Error					
					Bit-4	SIM Phase Cal error					
					Bit-5	SIM Ratio Csum Error					
					Bit-6	User Ratio Csum Error					
					Bit-7	User Gain Csum Error					
					Bit-8	User Phase Csum Error					
					Bit-9	DSP Board ID Csum Error					
					Bit-10	SIM Board ID Csum Error					
					Bit-11	User TDD Csum Error					
					Bit-12	DSP Integrity Csum Error					
					Bit-13	DSP Stack Overflow					
					Bit-14	CT\VT Scaling Error					
					Bit-15	Protocol Config Error					
3	40002	Amps A	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40003	Amps B	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40004	Amps C	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40005	Volts A	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40006	Volts B	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40007	Volts C	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40008	Watts Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) W	
3	40009	VARs Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) vars	
3	40010	Watts A	T15	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) W	
3	40011	Watts B	T15	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) W	
3	40012	Watts C	T15	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) W	
3	40013	VARs A	T15	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) vars	
3	40014	VARs B	T15	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) vars	
3	40015	VARs C	T15	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) vars	
3	40016	Amp Scale Factor	T10				Data	1000	9999	1	
3	40017	Volt Scale Factor	T10				Data	1000	9999	1	
3	40018	Amps N	T17	Amp Scale			Data	2047	4095	((1/2048) * 15 * Amp Scale) A	

Bitronics Legacy Modbus Register Assignments

Code	Modbus Address	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Pass
3	40019	Watt-Hrs Normal (High Word)	T1				Data	0	65536	65536 Kilowatt-Hours	
3	40020	Watt-Hrs Normal (Low Word)	T1				Data	0	65536	1 Kilowatt-Hour	
3	40021	Watt-Hrs Reverse (High Word)	T1				Data	0	65536	65536 Kilowatt-Hours	
3	40022	Watt-Hrs Reverse (Low Word)	T1				Data	0	65536	1 Kilowatt-Hour	
3	40023	VAR-Hrs Lag (High Word)	T1				Data	0	65536	65536 KilovarHours	
3	40024	VAR-Hrs Lag (Low Word)	T1				Data	0	65536	1 KilovarHour	
3	40025	VAR-Hrs Lead (High Word)	T1				Data	0	65536	65536 KilovarHours	
3	40026	VAR-Hrs Lead (Low Word)	T1				Data	0	65536	1 KilovarHour	
3	40027	Frequency Volts A	T8				Data	2000	8000	0.01 Hz	
3	40028	Volts A Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40029	Phase Angle Volts A Bus1-Bus2	T18				Data	247	3847	0.1 Degrees	
3	40030	Frequency Volts A Bus2	T8				Data	2000	8000	0.01 Hz	
3	40031	Heart Beat	T1				Data	0	65536	1 msec	
3	40032	Unused	T1		0	spare unused register	Data	0	0	0	
3	40033	VAs A	T15	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) VAs	
3	40034	VAs B	T15	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) VAs	
3	40035	VAs C	T15	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 1000 * Amp Scale * Volt Scale) VAs	
3	40036	VAs Total Geometric	T16	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) VAs	
3	40037	Power Factor A	T19				Data	1047	3047	0.001	
3	40038	Power Factor B	T19				Data	1047	3047	0.001	
3	40039	Power Factor C	T19				Data	1047	3047	0.001	
3	40040	Power Factor Total Geometric	T19				Data	1047	3047	0.001	
3,6,16	40041	Amp Scale Factor	T10				Setting	1000	9999	1	
3,6,16	40042	Amp Scale Factor Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40043	Volt Scale Factor	T10				Setting	1000	9999	1	
3,6,16	40044	Volt Scale Factor Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3	40045	Demand Amps A	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40046	Demand Amps B	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40047	Demand Amps C	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40048	Demand (Max) Amps A	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40049	Demand (Max) Amps B	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40050	Demand (Max) Amps C	T13	Amp Scale			Data	2047	4095	((1/2048) * 10 * Amp Scale) A	
3	40051	Demand Amps N	T17	Amp Scale			Data	2047	4095	((1/2048) * 15 * Amp Scale) A	
3	40052	Demand (Max) Amps N	T17	Amp Scale			Data	2047	4095	((1/2048) * 15 * Amp Scale) A	
3	40053	Demand Volts A	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40054	Demand Volts B	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40055	Demand Volts C	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40056	Demand (Max) Volts A	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40057	Demand (Max) Volts B	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	

Bitronics Legacy Modbus Register Assignments												
Code	**Modbus Address**		**Contents**	**Data**	**Scale**	**Ind**	**Values/Dependencies**	**Type**	**Min**	**Max**	**Step**	**Pass**
3	40058		Demand (Max) Volts C	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40059		Demand (Min) Volts A	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40060		Demand (Min) Volts B	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40061		Demand (Min) Volts C	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40062		Demand Watts Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) W	
3	40063		Demand (Max) Watts Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) W	
3	40064		Demand (Min) Watts Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) W	
3	40065		Demand VARs Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) vars	
3	40066		Demand (Max) VARs Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) vars	
3	40067		Demand (Min) VARs Total	T16	Amp Scale * Volt Scale			Data	0	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) vars	
3	40068		Demand VAs Total	T16	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) VAs	
3	40069		Demand (Max) VAs Total	T16	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) VAs	
3	40070		Demand (Min) VAs Total	T16	Amp Scale * Volt Scale			Data	2047	4095	((1/2048) * 3000 * Amp Scale * Volt Scale) VAs	
3	40071		Meter Type	T1		400 500	M87x Legacy Register Set M87x Legacy Register Set	Data	400	502	0	
3	40072		Protocol Version	T21				Data	0	65536	0.001	
3	40073		Factory Version Software	T21				Data	0	65536	0.001	
3	40074		DSP Version	T21				Data	0	65536	0.001	
3	40075		Volts N-G	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40076		Volts A-B	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40077		Volts B-C	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40078		Volts C-A	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40079		Volts N-G Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40080		Volts A Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40081		Volts B Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40082		Volts C Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40083		Volts AB Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40084		Volts BC Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40085		Volts CA Bus2	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40086		DIO#0 Input	T1		Bit-0 Bit-1 Bit-2 Bit-3 Bit-4	Digital I/O - Input 1 Digital I/O - Input 2 Digital I/O - Input 3 Digital I/O - Input 4 Digital I/O - Input 5	Data	0 - Low	1 - High	1	

Bitronics Legacy Modbus Register Assignments											
Code	Modbus Address	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Pass
					Bit-5	Digital I/O - Input 6					
					Bit-6	Digital I/O - Input 7					
					Bit-7	Digital I/O - Input 8					
					Bit-8	Digital I/O - Input 9					
					Bit-9	Digital I/O - Input 10					
					Bit-10	Digital I/O - Input 11					
					Bit-11	Digital I/O - Input 12					
					Bit-12	Digital I/O - Input 13					
					Bit-13	Digital I/O - Input 14					
					Bit-14	Digital I/O - Input 15					
					Bit-15	Digital I/O - Input 16					
3,6,16	40087	DIO#0 Output Register 1	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40088	DIO#0 Output Register 2	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40089	DIO#0 Output Register 3	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40090	DIO#0 Output Register 4	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40091	DIO#0 Output Register 5	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40092	DIO#0 Output Register 6	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40093	DIO#0 Output Register 7	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3,6,16	40094	DIO#0 Output Register 8	T20		0	Relay Off	Setting	0	65536	65536	
					65536	Relay Energized					
3	40095	Unused Register	T1		0	spare unused register	Data	0	0	0	
3,6,16	40096	VA/PF Calc. Type	T1		1	Arithmetic	Setting	1	4	1	
					2	Geometric					
					3	3 Element (L-N)					
					4	2 Element (L-L)					
3,6,16	40097	DIO#0 Debounce	T1				Setting	0	65536	1 usec	
3,6,16	40098	Log Interval	T1				Setting	0	720	1 min	
3,6,16	40099	Tag Register	T1				Setting	0	65536	1	
3,6,16	40100	Reset Energy	T20		0	Normal	Setting	0	65536	65536	
					65536	Reset					
3,6,16	40101	Reset Demand Amps	T20		0	Normal	Setting	0	65536	65536	
					65536	Reset					
3,6,16	40102	Reset Demand Volts	T20		0	Normal	Setting	0	65536	65536	
					65536	Reset					
3,6,16	40103	Reset Demand Power	T20		0	Normal	Setting	0	65536	65536	
					65536	Reset					
3,6,16	40104	Reset Demand Harmonic	T20		0	Normal	Setting	0	65536	65536	

Bitronics Legacy Modbus Register Assignments

Code	Modbus Address		Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Pass
						65536	Reset					
3,6,16	40105		Trigger Waveform	T20		0	Normal	Setting	0	65536	65536	
						65536	Reset					
3	40106		Demand Volts AB	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40107		Demand Volts BC	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40108		Demand Volts CA	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40109		Demand (Max) Volts AB	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40110		Demand (Max) Volts BC	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40111		Demand (Max) Volts CA	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40112		Demand (Min) Volts AB	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40113		Demand (Min) Volts BC	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3	40114		Demand (Min) Volts CA	T14	Volt Scale			Data	2047	4095	((1/2048) * 150 * Volt Scale) V	
3,6,16	40115		Xfmr Ratio Volts A	T10				Setting	1000	9999	1	
3,6,16	40116		Xfmr Ratio Divisor Volts A	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40117		Xfmr Ratio Volts B	T10				Setting	1000	9999	1	
3,6,16	40118		Xfmr Ratio Divisor Volts B	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40119		Xfmr Ratio Volts C	T10				Setting	1000	9999	1	
3,6,16	40120		Xfmr Ratio Divisor Volts C	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40121		Xfmr Ratio Volts N	T10				Setting	1000	9999	1	
3,6,16	40122		Xfmr Ratio Divisor Volts N	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40123		Xfmr Ratio Volts A Bus2	T10				Setting	1000	9999	1	
3,6,16	40124		Xfmr Ratio Divisor Volts A Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40125		Xfmr Ratio Volts B Bus2	T10				Setting	1000	9999	1	
3,6,16	40126		Xfmr Ratio Divisor Volts B Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40127		Xfmr Ratio Volts C Bus2	T10				Setting	1000	9999	1	
3,6,16	40128		Xfmr Ratio Divisor Volts C Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40129		Xfmr Ratio Volts N Bus2	T10				Setting	1000	9999	1	
3,6,16	40130		Xfmr Ratio Divisor Volts N Bus2	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40131		Xfmr Ratio Amps A	T10				Setting	1000	9999	1	
3,6,16	40132		Xfmr Ratio Divisor Amps A	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40133		Xfmr Ratio Amps B	T10				Setting	1000	9999	1	
3,6,16	40134		Xfmr Ratio Divisor Amps B	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40135		Xfmr Ratio Amps C	T10				Setting	1000	9999	1	
3,6,16	40136		Xfmr Ratio Divisor Amps C	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40137		Xfmr Ratio Amps N	T10				Setting	1000	9999	1	
3,6,16	40138		Xfmr Ratio Divisor Amps N	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40139		Xfmr Ratio Volts Aux1-Gnd	T10				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40140		Xfmr Ratio Divisor Volts Aux1-Gnd	T11				Setting	1000	9999	1	
3,6,16	40141		Xfmr Ratio Volts Aux2-Gnd	T10				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40142		Xfmr Ratio Divisor Volts Aux2-Gnd	T11				Setting	1000	9999	1	
3,6,16	40143		Xfmr Ratio Future Use	T10				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40144		Xfmr Ratio Divisor Future Use	T11				Setting	1000	9999	1	

Bitronics Legacy Modbus Register Assignments												
Code	**Modbus Address**		**Contents**	**Data**	**Scale**	**Ind**	**Values/Dependencies**	**Type**	**Min**	**Max**	**Step**	**Pass**
3,6,16	40145		Xfmr Ratio Future Use	T10				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40146		Xfmr Ratio Divisor Future Use	T11				Setting	1000	9999	1	
3,6,16	40147		Xfmr Ratio Volts AuxDiff	T10				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40148		Xfmr Ratio Divisor Volts AuxDiff	T11				Setting	1000	9999	1	
3,6,16	40149		Xfmr Ratio Amps Residual	T10				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	
3,6,16	40150		Xfmr Ratio Divisor Amps Residual	T11				Setting	1000	9999	1	

- When connected to 2 Element (DELTA or 3-wire) systems, the Per-Element quantities may have no direct physical meaning.

APPENDIX B BITRONICS MODBUS REGISTER ASSIGNMENTS

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,001	Health	Health	Health	Health	Health	Start of Configurable Measurements
40,002	RMS Amps A 1	Health	Health	Health	Health	
40,003	RMS Amps B 1	Register Set	Register Set	RMS Amps A 1	Register Set	
40,004	RMS Amps C 1	Meter Type	Meter Type	RMS Amps B 1	Meter Type	
40,005	RMS Volts A 1	Firmware Version	Firmware Version	RMS Amps C 1	Firmware Version	
40,006	RMS Volts B 1	Heart Beat	Heart Beat	RMS Amps N 1	Heart Beat	
40,007	RMS Volts C 1	VT 1 Scale Factor	VT 1 Scale Factor	RMS Amps Residual	RMS Amps A 1	
40,008	RMS Watts Total 1	VT 1 Scale Factor	VT 1 Scale Factor	RMS Volts A 1	RMS Amps B 1	
40,009	RMS VARs Total 1	CT 1 Scale Factor	CT 1 Scale Factor	RMS Volts B 1	RMS Amps C 1	
40,010	RMS Watts A 1	CT 1 Scale Factor	CT 1 Scale Factor	RMS Volts C 1	RMS Amps A 2	
40,011	RMS Watts B 1	VT 2 Scale Factor	VT 2 Scale Factor	RMS Volts N 1	RMS Amps B 2	
40,012	RMS Watts C 1	VT 2 Scale Factor	VT 2 Scale Factor	RMS Volts AB 1	RMS Amps C 2	
40,013	RMS VARs A 1	CT 2 Scale Factor	CT 2 Scale Factor	RMS Volts BC 1	RMS Volts A 1	
40,014	RMS VARs B 1	CT 2 Scale Factor	CT 2 Scale Factor	RMS Volts CA 1	RMS Volts B 1	
40,015	RMS VARs C 1	RMS Volts A 1	RMS Volts A 1	RMS Volts A 2	RMS Volts C 1	
40,016	CT Scale Factor	RMS Volts B 1	RMS Volts B 1	RMS Volts B 2	RMS Volts N 1	
40,017	VT Scale Factor	RMS Volts C 1	RMS Volts C 1	RMS Volts C 2	RMS Volts AB 1	
40,018	RMS Amps N 1	RMS Volts N 1	RMS Volts N 1	RMS Volts N 2	RMS Volts BC 1	
40,019	KWatt1-Hrs Normal	RMS Volts R 1	RMS Volts R 1	RMS Volts AB 2	RMS Volts CA 1	
40,020	KWatt1-Hrs Normal	RMS Volts R 2	RMS Volts R 2	RMS Volts BC 2	RMS Volts A 2	
40,021	KWatt1-Hrs Reverse	RMS Volts AB 1	RMS Volts AB 1	RMS Volts CA 2	RMS Volts B 2	
40,022	KWatt1-Hrs Reverse	RMS Volts BC 1	RMS Volts BC 1	RMS Watts A 1	RMS Volts C 2	
40,023	KVAR1-Hrs Lag	RMS Volts CA 1	RMS Volts CA 1	RMS Watts B 1	RMS Volts N 2	
40,024	KVAR1-Hrs Lag	RMS Amps A 1	RMS Amps A 1	RMS Watts C 1	RMS Volts AB 2	
40,025	KVAR1-Hrs Lead	RMS Amps B 1	RMS Amps B 1	RMS Watts Total 1	RMS Volts BC 2	
40,026	KVAR1-Hrs Lead	RMS Amps C 1	RMS Amps C 1	RMS VARs A 1	RMS Volts CA 2	
40,027	Frequency Volts A 1	RMS Amps N 1	RMS Amps N 1	RMS VARs B 1	RMS Volts R 1	
40,028	RMS Volts A 2	RMS Volts A 2	RMS Volts A 2	RMS VARs C 1	RMS Volts R 2	
40,029	Phase Angle Volts A 1- 2	RMS Volts B 2	RMS Volts B 2	RMS VARs Total 1	RMS Watts A 1	
40,030	Frequency Volts A 2	RMS Volts C 2	RMS Volts C 2	RMS VAs A 1	RMS Watts B 1	
40,031	Heart Beat	RMS Volts N 2	RMS Volts N 2	RMS VAs B 1	RMS Watts C 1	
40,032	Reserved	RMS Volts AB 2	RMS Volts AB 2	RMS VAs C 1	RMS Watts Total 1	
40,033	RMS VAs A 1	RMS Volts BC 2	RMS Volts BC 2	RMS VAs Total 1	RMS VARs A 1	
40,034	RMS VAs B 1	RMS Volts CA 2	RMS Volts CA 2	Power Factor A 1	RMS VARs B 1	
40,035	RMS VAs C 1	RMS Amps A 2	RMS Amps A 2	Power Factor B 1	RMS VARs C 1	

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,036	RMS VAs Total 1	RMS Amps B 2	RMS Amps B 2	Power Factor C 1	RMS VARs Total 1	
40,037	Power Factor A 1	RMS Amps C 2	RMS Amps C 2	Power Factor Total 1	RMS VAs A 1	
40,038	Power Factor B 1	Reserved for RMS Amps N 2	Reserved for RMS Amps N 2	Frequency Volts A 1	RMS VAs B 1	
40,039	Power Factor C 1	RMS Watts A 1	RMS Watts A 1	Frequency Volts B 1	RMS VAs C 1	
40,040	Power Factor Total 1	RMS Watts B 1	RMS Watts B 1	Frequency Volts C 1	RMS VAs Total 1	
40,041	CT Scale Factor	RMS Watts C 1	RMS Watts C 1	Frequency Volts A 2	Power Factor A 1	
40,042	CT Scale Factor	RMS Watts T 1	RMS Watts T 1	Frequency Volts B 2	Power Factor B 1	
40,043	VT Scale Factor	RMS VARs A 1	RMS VARs A 1	Frequency Volts C 2	Power Factor C 1	
40,044	VT Scale Factor	RMS VARs B 1	RMS VARs B 1	System Frequency	Power Factor Total 1	
40,045	Demand RMS Amps A 1	RMS VARs C 1	RMS VARs C 1	Phase Angle Volts A 1- 2	RMS Watts A 2	
40,046	Demand RMS Amps B 1	RMS VARs T 1	RMS VARs T 1	Phase Angle Volts B 1- 2	RMS Watts B 2	
40,047	Demand RMS Amps C 1	RMS VAs A 1	RMS VAs A 1	Phase Angle Volts C 1- 2	RMS Watts C 2	
40,048	Max Demand RMS Amps A 1	RMS VAs B 1	RMS VAs B 1	Phase Angle RMS Amps A 1 Harmonic 01	RMS Watts Total 2	
40,049	Max Demand RMS Amps B 1	RMS VAs C 1	RMS VAs C 1	Phase Angle RMS Amps B 1 Harmonic 01	RMS VARs A 2	
40,050	Max Demand RMS Amps C 1	RMS VAs T 1	RMS VAs T 1	Phase Angle RMS Amps C 1 Harmonic 01	RMS VARs B 2	
40,051	Demand RMS Amps N 1	Power Factor A 1	Power Factor A 1	Phase Angle RMS Volts A 1 Harmonic 01	RMS VARs C 2	
40,052	Max Demand RMS Amps N 1	Power Factor B 1	Power Factor B 1	Phase Angle RMS Volts B 1 Harmonic 01	RMS VARs Total 2	
40,053	Demand RMS Volts A 1	Power Factor C 1	Power Factor C 1	Phase Angle RMS Volts C 1 Harmonic 01	Reserved (returns 0)	
40,054	Demand RMS Volts B 1	Power Factor T 1	Power Factor T 1	VA/PF Calc. Type	Reserved (returns 0)	
40,055	Demand RMS Volts C 1	Meter Type	Meter Type	Meter Type	Meter Type	
40,056	Max Demand RMS Volts A 1	RMS Watts A 2	RMS Watts A 2	VT Scale Factor	RMS VAs A 2	
40,057	Max Demand RMS Volts B 1	RMS Watts B 2	RMS Watts B 2	VT Scale Factor	RMS VAs B 2	
40,058	Max Demand RMS Volts C 1	RMS Watts C 2	RMS Watts C 2	CT Scale Factor	RMS VAs C 2	
40,059	Min Demand RMS Volts A 1	RMS Watts T 2	RMS Watts T 2	CT Scale Factor	RMS VAs Total 2	
40,060	Min Demand RMS Volts B 1	RMS VARs A 2	RMS VARs A 2	Xfmr Ratio Volts A 1	Power Factor A 2	
40,061	Min Demand RMS Volts C 1	RMS VARs B 2	RMS VARs B 2	Xfmr Ratio Volts A 1	Power Factor B 2	
40,062	Demand RMS Watts Total 1	RMS VARs C 2	RMS VARs C 2	Xfmr Ratio Volts B 1	Power Factor C 2	
40,063	Max Demand RMS Watts Total 1	RMS VARs T 2	RMS VARs T 2	Xfmr Ratio Volts B 1	Power Factor Total 2	
40,064	Min Demand RMS Watts Total 1	RMS VAs A 2	RMS VAs A 2	Xfmr Ratio Volts C 1	Reserved (returns 0)	
40,065	Demand RMS VARs Total 1	RMS VAs B 2	RMS VAs B 2	Xfmr Ratio Volts C 1	Reserved (returns 0)	
40,066	Max Demand RMS VARs Total 1	RMS VAs C 2	RMS VAs C 2	Xfmr Ratio Volts N 1	Reserved (returns 0)	
40,067	Min Demand RMS VARs Total 1	RMS VAs T 2	RMS VAs T 2	Xfmr Ratio Volts N 1	Reserved (returns 0)	

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,068	Demand RMS VAs Total 1	Reserved (returns 0)	Reserved (returns 0)	Xfmr Ratio Volts A 2	Reserved (returns 0)	
40,069	Max Demand RMS VAs Total 1	Reserved (returns 0)	Reserved (returns 0)	Xfmr Ratio Volts A 2	Reserved (returns 0)	
40,070	Min Demand RMS VAs Total 1	Reserved (returns 0)	Reserved (returns 0)	Xfmr Ratio Volts B 2	Reserved (returns 0)	
40,071	Meter Type	Meter Type	Meter Type	Xfmr Ratio Volts B 2	Meter Type	
40,072	Protocol Version	Power Factor A 2	Power Factor A 2	Xfmr Ratio Volts C 2	Frequency Volts A 1	
40,073	Software Version	Power Factor B 2	Power Factor B 2	Xfmr Ratio Volts C 2	Frequency Volts B 1	
40,074	DSP Version	Power Factor C 2	Power Factor C 2	Xfmr Ratio Volts N 2	Frequency Volts C 1	
40,075	RMS Volts N 1	Power Factor T 2	Power Factor T 2	Xfmr Ratio Volts N 2	Frequency Volts A 2	
40,076	RMS Volts AB 1	VA/PF Calc. Type	VA/PF Calc. Type	Xfmr Ratio Amps A 1	Frequency Volts B 2	
40,077	RMS Volts BC 1	KWatt1-Hrs Normal	KWatt1-Hrs Normal	Xfmr Ratio Amps A 1	Frequency Volts C 2	
40,078	RMS Volts CA 1	KWatt1-Hrs Normal	KWatt1-Hrs Normal	Xfmr Ratio Amps B 1	Frequency Volts R 1	
40,079	RMS Volts N 2	KWatt1-Hrs Reverse	KWatt1-Hrs Reverse	Xfmr Ratio Amps B 1	Frequency Volts R 2	
40,080	RMS Volts A 2	KWatt1-Hrs Reverse	KWatt1-Hrs Reverse	Xfmr Ratio Amps C 1	System Frequency	
40,081	RMS Volts B 2	KVAR1-Hrs Lag	KVAR1-Hrs Lag	Xfmr Ratio Amps C 1	Reserved for System Frequency 2	
40,082	RMS Volts C 2	KVAR1-Hrs Lag	KVAR1-Hrs Lag	Xfmr Ratio Amps N 1	Phase Angle Volts A 1 - 2	
40,083	RMS Volts AB 2	KVAR1-Hrs Lead	KVAR1-Hrs Lead	Xfmr Ratio Amps N 1	Phase Angle Volts B 1 - 2	
40,084	RMS Volts BC 2	KVAR1-Hrs Lead	KVAR1-Hrs Lead	User Gain Volts A 1	Phase Angle Volts C 1 - 2	
40,085	RMS Volts CA 2	KWatt2-Hrs Normal	KWatt2-Hrs Normal	User Gain Volts B 1	Phase Angle Volts A 1 - R 1	
40,086	DIO#0 Input	KWatt2-Hrs Normal	KWatt2-Hrs Normal	User Gain Volts C 1	Phase Angle Volts B 1 - R 1	
40,087	DIO#0 Output 1	KWatt2-Hrs Reverse	KWatt2-Hrs Reverse	User Gain Volts N 1	Phase Angle Volts C 1 - R 1	
40,088	DIO#0 Output 2	KWatt2-Hrs Reverse	KWatt2-Hrs Reverse	User Gain Volts A 2	Phase Angle Volts A 1 - R 2	
40,089	DIO#0 Output 3	KVAR2-Hrs Lag	KVAR2-Hrs Lag	User Gain Volts B 2	Phase Angle Volts B 1 - R 2	
40,090	DIO#0 Output 4	KVAR2-Hrs Lag	KVAR2-Hrs Lag	User Gain Volts C 2	Phase Angle Volts C 1 - R 2	
40,091	DIO#1 Output 1	KVAR2-Hrs Lead	KVAR2-Hrs Lead	User Gain Volts N 2	Phase Angle RMS Amps A 1 Harmonic 01	
40,092	DIO#1 Output 2	KVAR2-Hrs Lead	KVAR2-Hrs Lead	User Gain Amps A 1	Phase Angle RMS Amps B 1 Harmonic 01	
40,093	DIO#1 Output 3	System Frequency	System Frequency	User Gain Amps B 1	Phase Angle RMS Amps C 1 Harmonic 01	
40,094	DIO#1 Output 4	Reserved for System Frequency 2	Reserved for System Frequency 2	User Gain Amps C 1	Phase Angle RMS Amps A 2 Harmonic 01	
40,095	Reserved	Reserved (returns 0)	Reserved (returns 0)	User Gain Amps N 1	Phase Angle RMS Amps B 2 Harmonic 01	
40,096	VA/PF Calc. Type	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts A 1	Phase Angle RMS Amps C 2 Harmonic 01	

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,097	DIO#0 Debounce	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts B 1	Phase Angle RMS Volts A 1 Harmonic 01	
40,098	Log Interval	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts C 1	Phase Angle RMS Volts B 1 Harmonic 01	
40,099	Tag Register	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts N 1	Phase Angle RMS Volts C 1 Harmonic 01	
40,100	Reset Energy	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts A 2	Phase Angle RMS Volts A 2 Harmonic 01	
40,101	Reset Demand Amps	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts B 2	Phase Angle RMS Volts B 2 Harmonic 01	
40,102	Reset Demand Volts	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts C 2	Phase Angle RMS Volts C 2 Harmonic 01	
40,103	Reset Demand Power	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Volts N 2	VT 1 Scale Factor	
40,104	Reset Demand Harmonic	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Amps A 1	VT 1 Scale Factor	
40,105	Trigger Waveform 1 Recorder	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Amps B 1	CT 1 Scale Factor	
40,106	Demand RMS Volts AB 1	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Amps C 1	CT 1 Scale Factor	
40,107	Demand RMS Volts BC 1	Reserved (returns 0)	Reserved (returns 0)	User Phase Correction Amps N 1	VT 2 Scale Factor	
40,108	Demand RMS Volts CA 1	Reserved (returns 0)	Reserved (returns 0)	Start of User Configurable Measurements	VT 2 Scale Factor	
40,109	Max Demand RMS Volts AB 1	Reserved (returns 0)	Reserved (returns 0)		CT 2 Scale Factor	
40,110	Max Demand RMS Volts BC 1	Reserved (returns 0)	Reserved (returns 0)		CT 2 Scale Factor	
40,111	Max Demand RMS Volts CA 1	Heartbeat	Heartbeat		Xfmr Ratio Volts A 1	
40,112	Min Demand RMS Volts AB 1	VT 1 Scale Factor	VT 1 Scale Factor		Xfmr Ratio Volts A 1	
40,113	Min Demand RMS Volts BC 1	VT 1 Scale Factor	VT 1 Scale Factor		Xfmr Ratio Volts B 1	
40,114	Min Demand RMS Volts CA 1	CT 1 Scale Factor	CT 1 Scale Factor		Xfmr Ratio Volts B 1	
40,115	Xfmr Ratio Volts A 1	CT 1 Scale Factor	CT 1 Scale Factor		Xfmr Ratio Volts C 1	
40,116	Xfmr Ratio Volts A 1	System Frequency	System Frequency		Xfmr Ratio Volts C 1	
40,117	Xfmr Ratio Volts B 1	Demand RMS Amps A 1	Demand RMS Amps A 1		Xfmr Ratio Volts N 1	
40,118	Xfmr Ratio Volts B 1	Demand RMS Amps B 1	Demand RMS Amps B 1		Xfmr Ratio Volts N 1	
40,119	Xfmr Ratio Volts C 1	Demand RMS Amps C 1	Demand RMS Amps C 1		Xfmr Ratio Volts A 2	
40,120	Xfmr Ratio Volts C 1	Demand RMS Amps N 1	Demand RMS Amps N 1		Xfmr Ratio Volts A 2	
40,121	Xfmr Ratio Volts N 1	Max Demand RMS Amps A 1	Max Demand RMS Amps A 1		Xfmr Ratio Volts B 2	
40,122	Xfmr Ratio Volts N 1	Max Demand RMS Amps B 1	Max Demand RMS Amps B 1		Xfmr Ratio Volts B 2	
40,123	Xfmr Ratio Volts A 2	Max Demand RMS Amps C 1	Max Demand RMS Amps C 1		Xfmr Ratio Volts C 2	

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,124	Xfmr Ratio Volts A 2	Max Demand RMS Amps N 1	Max Demand RMS Amps N 1		Xfmr Ratio Volts C 2	
40,125	Xfmr Ratio Volts B 2	Demand RMS Volts A 1	Demand RMS Volts A 1		Xfmr Ratio Volts N 2	
40,126	Xfmr Ratio Volts B 2	Demand RMS Volts B 1	Demand RMS Volts B 1		Xfmr Ratio Volts N 2	
40,127	Xfmr Ratio Volts C 2	Demand RMS Volts C 1	Demand RMS Volts C 1		Xfmr Ratio Volts R 1	
40,128	Xfmr Ratio Volts C 2	Demand RMS Volts N 1	Demand RMS Volts N 1		Xfmr Ratio Volts R 1	
40,129	Xfmr Ratio Volts N 2	Max Demand RMS Volts A 1	Max Demand RMS Volts A 1		Xfmr Ratio Volts R 2	
40,130	Xfmr Ratio Volts N 2	Max Demand RMS Volts B 1	Max Demand RMS Volts B 1		Xfmr Ratio Volts R 2	
40,131	Xfmr Ratio Amps A 1	Max Demand RMS Volts C 1	Max Demand RMS Volts C 1		Xfmr Ratio Amps A 1	
40,132	Xfmr Ratio Amps A 1	Max Demand RMS Volts N 1	Max Demand RMS Volts N 1		Xfmr Ratio Amps A 1	
40,133	Xfmr Ratio Amps B 1	Min Demand RMS Volts A 1	Min Demand RMS Volts A 1		Xfmr Ratio Amps B 1	
40,134	Xfmr Ratio Amps B 1	Min Demand RMS Volts B 1	Min Demand RMS Volts B 1		Xfmr Ratio Amps B 1	
40,135	Xfmr Ratio Amps C 1	Min Demand RMS Volts C 1	Min Demand RMS Volts C 1		Xfmr Ratio Amps C 1	
40,136	Xfmr Ratio Amps C 1	Min Demand RMS Volts N 1	Min Demand RMS Volts N 1		Xfmr Ratio Amps C 1	
40,137	Xfmr Ratio Amps N 1	Demand RMS Volts AB 1	Demand RMS Volts AB 1		Xfmr Ratio Amps N 1	
40,138	Xfmr Ratio Amps N 1	Demand RMS Volts BC 1	Demand RMS Volts BC 1		Xfmr Ratio Amps N 1	
40,139	Xfmr Ratio Volts Aux1-Gnd	Demand RMS Volts CA 1	Demand RMS Volts CA 1		Xfmr Ratio Amps A 2	
40,140	Xfmr Ratio Volts Aux1-Gnd	Min Demand RMS Volts AB 1	Min Demand RMS Volts AB 1		Xfmr Ratio Amps A 2	
40,141	Xfmr Ratio Volts Aux2-Gnd	Min Demand RMS Volts BC 1	Min Demand RMS Volts BC 1		Xfmr Ratio Amps B 2	
40,142	Xfmr Ratio Volts Aux2-Gnd	Min Demand RMS Volts CA 1	Min Demand RMS Volts CA 1		Xfmr Ratio Amps B 2	
40,143	Xfmr Ratio Volts Int. 3V	Max Demand RMS Volts AB 1	Max Demand RMS Volts AB 1		Xfmr Ratio Amps C 2	
40,144	Xfmr Ratio Volts Int. 3V	Max Demand RMS Volts BC 1	Max Demand RMS Volts BC 1		Xfmr Ratio Amps C 2	
40,145	Xfmr Ratio Volts Int. 5V	Max Demand RMS Volts CA 1	Max Demand RMS Volts CA 1		Reserved for Xfmr Ratio Amps N 2	
40,146	Xfmr Ratio Volts Int. 5V	Demand RMS Watts Total 1	Demand RMS Watts Total 1		Reserved for Xfmr Ratio Amps N 2	
40,147	Xfmr Ratio Volts AuxDiff	Demand RMS VARs Total 1	Demand RMS VARs Total 1		User Gain Volts A 1	
40,148	Xfmr Ratio Volts AuxDiff	Demand RMS VAs Total 1	Demand RMS VAs Total 1		User Gain Volts B 1	
40,149	Xfmr Ratio Amps Residual 1	Max Demand RMS Watts Total 1	Max Demand RMS Watts Total 1		User Gain Volts C 1	
40,150	Xfmr Ratio Amps Residual 1	Max Demand RMS VARs Total 1	Max Demand RMS VARs Total 1		User Gain Volts N 1	
40,151	No User Configurable Measurements	Max Demand RMS VAs Total 1	Max Demand RMS VAs Total 1		User Gain Volts A 2	
40,152		Min Demand RMS Watts Total 1	Min Demand RMS Watts Total 1		User Gain Volts B 2	
40,153		Min Demand RMS VARs Total 1	Min Demand RMS VARs Total 1		User Gain Volts C 2	
40,154		Min Demand RMS VAs Total 1	Min Demand RMS VAs Total 1		User Gain Volts N 2	
40,155		VT 2 Scale Factor	VT 2 Scale Factor		User Gain Volts R 1	

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,156		VT 2 Scale Factor	VT 2 Scale Factor		User Gain Volts R 2	
40,157		CT 2 Scale Factor	CT 2 Scale Factor		User Gain Amps A 1	
40,158		CT 2 Scale Factor	CT 2 Scale Factor		User Gain Amps B 1	
40,159		Reserved for System Frequency 2	Reserved for System Frequency 2		User Gain Amps C 1	
40,160		Demand RMS Amps A 2	Demand RMS Amps A 2		User Gain Amps N 2	
40,161		Demand RMS Amps B 2	Demand RMS Amps B 2		User Gain Amps A 2	
40,162		Demand RMS Amps C 2	Demand RMS Amps C 2		User Gain Amps B 2	
40,163		Reserved for Demand RMS Amps N 2	Reserved for Demand RMS Amps N 2		User Gain Amps C 2	
40,164		Max Demand RMS Amps A 2	Max Demand RMS Amps A 2		Reserved for User Gain Amsp N 2	
40,165		Max Demand RMS Amps B 2	Max Demand RMS Amps B 2		User Phase Correction Volts A 1	
40,166		Max Demand RMS Amps C 2	Max Demand RMS Amps C 2		User Phase Correction Volts B 1	
40,167		Reserved for Max Demand RMS Amps N 2	Reserved for Max Demand RMS Amps N 2		User Phase Correction Volts C 1	
40,168		Demand RMS Volts A 2	Demand RMS Volts A 2		User Phase Correction Volts N 1	
40,169		Demand RMS Volts B 2	Demand RMS Volts B 2		User Phase Correction Volts A 2	
40,170		Demand RMS Volts C 2	Demand RMS Volts C 2		User Phase Correction Volts B 2	
40,171		Demand RMS Volts N 2	Demand RMS Volts N 2		User Phase Correction Volts C 2	
40,172		Max Demand RMS Volts A 2	Max Demand RMS Volts A 2		User Phase Correction Volts N 2	
40,173		Max Demand RMS Volts B 2	Max Demand RMS Volts B 2		User Phase Correction Volts R 1	
40,174		Max Demand RMS Volts C 2	Max Demand RMS Volts C 2		User Phase Correction Volts R 2	
40,175		Max Demand RMS Volts N 2	Max Demand RMS Volts N 2		User Phase Correction Amps A 1	
40,176		Min Demand RMS Volts A 2	Min Demand RMS Volts A 2		User Phase Correction Amps B 1	
40,177		Min Demand RMS Volts B 2	Min Demand RMS Volts B 2		User Phase Correction Amps C 1	
40,178		Min Demand RMS Volts C 2	Min Demand RMS Volts C 2		User Phase Correction Amps N 1	
40,179		Min Demand RMS Volts N 2	Min Demand RMS Volts N 2		User Phase Correction Amps A 2	
40,180		Demand RMS Volts AB 2	Demand RMS Volts AB 2		User Phase Correction Amps B 2	
40,181		Demand RMS Volts BC 2	Demand RMS Volts BC 2		User Phase Correction	

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
					Amps C 2	
40,182		Demand RMS Volts CA 2	Demand RMS Volts CA 2		Reserved For User Phase Correction Amps N 2	
40,183		Min Demand RMS Volts AB 2	Min Demand RMS Volts AB 2		VA/PF Calc. Type	
40,184		Min Demand RMS Volts BC 2	Min Demand RMS Volts BC 2		File Select Rgstr	
40,185		Min Demand RMS Volts CA 2	Min Demand RMS Volts CA 2		File Delete Rgstr	
40,186		Max Demand RMS Volts AB 2	Max Demand RMS Volts AB 2		Reserved (returns 0)	
40,187		Max Demand RMS Volts BC 2	Max Demand RMS Volts BC 2		Reserved (returns 0)	
40,188		Max Demand RMS Volts CA 2	Max Demand RMS Volts CA 2		Reserved (returns 0)	
40,189		Demand RMS Watts Total 2	Demand RMS Watts Total 2		Reserved (returns 0)	
40,190		Demand RMS VARs Total 2	Demand RMS VARs Total 2		Reserved (returns 0)	
40,191		Demand RMS VAs Total 2	Demand RMS VAs Total 2		Reserved (returns 0)	
40,192		Max Demand RMS Watts Total 2	Max Demand RMS Watts Total 2		Reserved (returns 0)	
40,193		Max Demand RMS VARs Total 2	Max Demand RMS VARs Total 2		Reserved (returns 0)	
40,194		Max Demand RMS VAs Total 2	Max Demand RMS VAs Total 2		Reserved (returns 0)	
40,195		Min Demand RMS Watts Total 2	Min Demand RMS Watts Total 2		Reserved (returns 0)	
40,196		Min Demand RMS VARs Total 2	Min Demand RMS VARs Total 2		Start of User Configurable Measurements	
40,197		Min Demand RMS VAs Total 2	Min Demand RMS VAs Total 2			
40,198		Reserved (returns 0)	Reserved (returns 0)			
40,199		Reserved (returns 0)	Reserved (returns 0)			
40,200		Reserved (returns 0)	Reserved (returns 0)			
40,201		Reserved (returns 0)	Reserved (returns 0)			
40,202		Reserved (returns 0)	Reserved (returns 0)			
40,203		Reserved (returns 0)	Reserved (returns 0)			
40,204		Reserved (returns 0)	Reserved (returns 0)			
40,205		Reserved (returns 0)	Reserved (returns 0)			
40,206		Reserved (returns 0)	Reserved (returns 0)			
40,207		Reserved (returns 0)	Reserved (returns 0)			
40,208		Reserved (returns 0)	Reserved (returns 0)			
40,209		Reserved (returns 0)	Reserved (returns 0)			
40,210		Reserved (returns 0)	Reserved (returns 0)			
40,211		Phase Angle Volts A 1- 2	Phase Angle Volts A 1- 2			
40,212		Phase Angle Volts B 1- 2	Phase Angle Volts B 1- 2			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,213		Phase Angle Volts C 1- 2	Phase Angle Volts C 1- 2			
40,214		Phase Angle Volts A 1- R 1	Phase Angle Volts A 1- R 1			
40,215		Phase Angle Volts B 1- R 1	Phase Angle Volts B 1- R 1			
40,216		Phase Angle Volts C 1- R 1	Phase Angle Volts C 1- R 1			
40,217		Phase Angle Volts A 1- R 2	Phase Angle Volts A 1- R 2			
40,218		Phase Angle Volts B 1- R 2	Phase Angle Volts B 1- R 2			
40,219		Phase Angle Volts C 1- R 2	Phase Angle Volts C 1- R 2			
40,220		RMS Volts A 1	RMS Volts A 1			
40,221		RMS Volts B 1	RMS Volts B 1			
40,222		RMS Volts C 1	RMS Volts C 1			
40,223		RMS Volts R 1	RMS Volts R 1			
40,224		RMS Volts R 2	RMS Volts R 2			
40,225		Frequency Volts A 1	Frequency Volts A 1			
40,226		Frequency Volts B 1	Frequency Volts B 1			
40,227		Frequency Volts C 1	Frequency Volts C 1			
40,228		Frequency R 1	Frequency R 1			
40,229		Frequency R 2	Frequency R 2			
40,230		RMS Volts A 2	RMS Volts A 2			
40,231		RMS Volts B 2	RMS Volts B 2			
40,232		RMS Volts C 2	RMS Volts C 2			
40,233		Frequency Volts A 2	Frequency Volts A 2			
40,234		Frequency Volts B 2	Frequency Volts B 2			
40,235		Frequency Volts C 2	Frequency Volts C 2			
40,236		Reserved (returns 0)	Reserved (returns 0)			
40,237		Reserved (returns 0)	Reserved (returns 0)			
40,238		Reserved (returns 0)	Reserved (returns 0)			
40,239		Reserved (returns 0)	Reserved (returns 0)			
40,240		Reserved (returns 0)	Reserved (returns 0)			
40,241		Reserved (returns 0)	Reserved (returns 0)			
40,242		Reserved (returns 0)	Reserved (returns 0)			
40,243		Reserved (returns 0)	Reserved (returns 0)			
40,244		Reserved (returns 0)	Reserved (returns 0)			
40,245		Reserved (returns 0)	Reserved (returns 0)			
40,246		Reserved (returns 0)	Reserved (returns 0)			
40,247		Reserved (returns 0)	Reserved (returns 0)			
40,248		Reserved (returns 0)	Reserved (returns 0)			
40,249		Reserved (returns 0)	Reserved (returns 0)			
40,250		Reserved (returns 0)	Reserved (returns 0)			
40,251		DSP Version	DSP Version			
40,252		Protocol Version	Protocol Version			
40,253		Config Register 1	Config Register 1			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,254		Config Register 2	Config Register 2			
40,255		Tag Register	Tag Register			
40,256		VT 1 Scale Factor	VT 1 Scale Factor			
40,257		VT 1 Scale Factor	VT 1 Scale Factor			
40,258		CT 1 Scale Factor	CT 1 Scale Factor			
40,259		CT 1 Scale Factor	CT 1 Scale Factor			
40,260		VT 2 Scale Factor	VT 2 Scale Factor			
40,261		VT 2 Scale Factor	VT 2 Scale Factor			
40,262		CT 2 Scale Factor	CT 2 Scale Factor			
40,263		CT 2 Scale Factor	CT 2 Scale Factor			
40,264		Xfmr Ratio Volts A 1	Xfmr Ratio Volts A 1			
40,265		Xfmr Ratio Volts A 1	Xfmr Ratio Volts A 1			
40,266		Xfmr Ratio Volts B 1	Xfmr Ratio Volts B 1			
40,267		Xfmr Ratio Volts B 1	Xfmr Ratio Volts B 1			
40,268		Xfmr Ratio Volts C 1	Xfmr Ratio Volts C 1			
40,269		Xfmr Ratio Volts C 1	Xfmr Ratio Volts C 1			
40,270		Xfmr Ratio Volts N 1	Xfmr Ratio Volts N 1			
40,271		Xfmr Ratio Volts N 1	Xfmr Ratio Volts N 1			
40,272		Xfmr Ratio Amps A 1	Xfmr Ratio Amps A 1			
40,273		Xfmr Ratio Amps A 1	Xfmr Ratio Amps A 1			
40,274		Xfmr Ratio Amps B 1	Xfmr Ratio Amps B 1			
40,275		Xfmr Ratio Amps B 1	Xfmr Ratio Amps B 1			
40,276		Xfmr Ratio Amps C 1	Xfmr Ratio Amps C 1			
40,277		Xfmr Ratio Amps C 1	Xfmr Ratio Amps C 1			
40,278		Xfmr Ratio Amps N 1	Xfmr Ratio Amps N 1			
40,279		Xfmr Ratio Amps N 1	Xfmr Ratio Amps N 1			
40,280		Xfmr Ratio Volts A 2	Xfmr Ratio Volts A 2			
40,281		Xfmr Ratio Volts A 2	Xfmr Ratio Volts A 2			
40,282		Xfmr Ratio Volts B 2	Xfmr Ratio Volts B 2			
40,283		Xfmr Ratio Volts B 2	Xfmr Ratio Volts B 2			
40,284		Xfmr Ratio Volts C 2	Xfmr Ratio Volts C 2			
40,285		Xfmr Ratio Volts C 2	Xfmr Ratio Volts C 2			
40,286		Xfmr Ratio Volts N 2	Xfmr Ratio Volts N 2			
40,287		Xfmr Ratio Volts N 2	Xfmr Ratio Volts N 2			
40,288		Xfmr Ratio Amps A 2	Xfmr Ratio Amps A 2			
40,289		Xfmr Ratio Amps A 2	Xfmr Ratio Amps A 2			
40,290		Xfmr Ratio Amps B 2	Xfmr Ratio Amps B 2			
40,291		Xfmr Ratio Amps B 2	Xfmr Ratio Amps B 2			
40,292		Xfmr Ratio Amps C 2	Xfmr Ratio Amps C 2			
40,293		Xfmr Ratio Amps C 2	Xfmr Ratio Amps C 2			
40,294		Reserved for Xfmr Ratio	Reserved for Xfmr Ratio			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
		Amps N 2	Amps N 2			
40,295		Reserved for Xfmr Ratio Amps N 2	Reserved for Xfmr Ratio Amps N 2			
40,296		Xfmr Ratio Volts R 1	Xfmr Ratio Volts R 1			
40,297		Xfmr Ratio Volts R 1	Xfmr Ratio Volts R 1			
40,298		Xfmr Ratio Volts R 2	Xfmr Ratio Volts R 2			
40,299		Xfmr Ratio Volts R 2	Xfmr Ratio Volts R 2			
40,300		File Select Rgstr	File Select Rgstr			
40,301		File Delete Rgstr	File Delete Rgstr			
40,302		Time Sync Error (msec)	Time Sync Error (msec)			
40,303		IrigB Time Sync (0 or 1)	IrigB Time Sync (0 or 1)			
40,304		(UCA) Network Time (0 or 1))	(UCA) Network Time (0 or 1))			
40,305		SNTP Time Sync (0 or 1)	SNTP Time Sync (0 or 1)			
40,306		DNP Time Sync (0 or 1)	DNP Time Sync (0 or 1)			
40,307		Reserved (returns 0)	Reserved (returns 0)			
40,308		Best Clock Source (0 thru 5)	Best Clock Source (0 thru 5)			
40,309		Reserved (returns 0)	Reserved (returns 0)			
40,310		Reserved (returns 0)	Reserved (returns 0)			
40,311		Reserved (returns 0)	Reserved (returns 0)			
40,312		Reserved (returns 0)	Reserved (returns 0)			
40,313		Reserved (returns 0)	Reserved (returns 0)			
40,314		Reserved (returns 0)	Reserved (returns 0)			
40,315		Reserved (returns 0)	Reserved (returns 0)			
40,316		Reserved (returns 0)	Reserved (returns 0)			
40,317		Reserved (returns 0)	Reserved (returns 0)			
40,318		Reserved (returns 0)	Reserved (returns 0)			
40,319		Reserved (returns 0)	Reserved (returns 0)			
40,320		Reserved (returns 0)	Reserved (returns 0)			
40,321		DIO#0 Input	DIO#0 Input			
40,322		DIO#0 Output 1	DIO#0 Output 1			
40,323		DIO#0 Output 2	DIO#0 Output 2			
40,324		DIO#0 Output 3	DIO#0 Output 3			
40,325		DIO#0 Output 4	DIO#0 Output 4			
40,326		DIO#1 Input	DIO#1 Input			
40,327		DIO#1 Output 1	DIO#1 Output 1			
40,328		DIO#1 Output 2	DIO#1 Output 2			
40,329		DIO#1 Output 3	DIO#1 Output 3			
40,330		DIO#1 Output 4	DIO#1 Output 4			
40,331		DIO#2 Input	DIO#2 Input			
40,332		DIO#2 Output 1	DIO#2 Output 1			
40,333		DIO#2 Output 2	DIO#2 Output 2			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,334		DIO#2 Output 3	DIO#2 Output 3			
40,335		DIO#2 Output 4	DIO#2 Output 4			
40,336		DIO#3 Input	DIO#3 Input			
40,337		DIO#3 Output 1	DIO#3 Output 1			
40,338		DIO#3 Output 2	DIO#3 Output 2			
40,339		DIO#3 Output 3	DIO#3 Output 3			
40,340		DIO#3 Output 4	DIO#3 Output 4			
40,341		DIO#4 Input	DIO#4 Input			
40,342		DIO#4 Output 1	DIO#4 Output 1			
40,343		DIO#4 Output 2	DIO#4 Output 2			
40,344		DIO#4 Output 3	DIO#4 Output 3			
40,345		DIO#4 Output 4	DIO#4 Output 4			
40,346		DIO#5 Input	DIO#5 Input			
40,347		DIO#5 Output 1	DIO#5 Output 1			
40,348		DIO#5 Output 2	DIO#5 Output 2			
40,349		DIO#5 Output 3	DIO#5 Output 3			
40,350		DIO#5 Output 4	DIO#5 Output 4			
40,351		DIO#6 Input	DIO#6 Input			
40,352		DIO#6 Output 1	DIO#6 Output 1			
40,353		DIO#6 Output 2	DIO#6 Output 2			
40,354		DIO#6 Output 3	DIO#6 Output 3			
40,355		DIO#6 Output 4	DIO#6 Output 4			
40,356		Reserved (returns 0)	Reserved (returns 0)			
40,357		Reserved (returns 0)	Reserved (returns 0)			
40,358		Reserved (returns 0)	Reserved (returns 0)			
40,359		Reserved (returns 0)	Reserved (returns 0)			
40,360		Reserved (returns 0)	Reserved (returns 0)			
40,361		Reserved (returns 0)	Reserved (returns 0)			
40,362		Reserved (returns 0)	Reserved (returns 0)			
40,363		Reserved (returns 0)	Reserved (returns 0)			
40,364		Reserved (returns 0)	Reserved (returns 0)			
40,365		Reserved (returns 0)	Reserved (returns 0)			
40,366		Reserved (returns 0)	Reserved (returns 0)			
40,367		Reserved (returns 0)	Reserved (returns 0)			
40,368		Reserved (returns 0)	Reserved (returns 0)			
40,369		Reserved (returns 0)	Reserved (returns 0)			
40,370		Reserved (returns 0)	Reserved (returns 0)			
40,371		Reset Energy	Reset Energy			
40,372		Reset Demand Amps	Reset Demand Amps			
40,373		Reset Demand Volts	Reset Demand Volts			
40,374		Reset Demand Power	Reset Demand Power			
40,375		Reset Demand Harmonic	Reset Demand Harmonic			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,376		Reset Received [UCA] GOOSE Parameters **[NOTE: This is now referred to as GSSE]**	Reset Received [UCA] GOOSE Parameters **[NOTE: This is now referred to as GSSE]**			
40,377		WR1 Recorder Started	WR1 Recorder Started			
40,378		WR1 Recorder Completed	WR1 Recorder Completed			
40,379		WR1 Recorder Memory Low	WR1 Recorder Memory Low			
40,380		Trigger WR1 Recorder	Trigger WR1 Recorder			
40,381		WR1 Recorder Active	WR1 Recorder Active			
40,382		WR2 Recorder Started	WR2 Recorder Started			
40,383		WR2 Recorder Completed	WR2 Recorder Completed			
40,384		WR2 Recorder Memory Low	WR2 Recorder Memory Low			
40,385		Trigger WR2 Recorder	Trigger WR2 Recorder			
40,386		WR2 Recorder Active	WR2 Recorder Active			
40,387		DR1 Recorder Started	DR1 Recorder Started			
40,388		DR1 Recorder Completed	DR1 Recorder Completed			
40,389		DR1 Recorder Memory Low	DR1 Recorder Memory Low			
40,390		Trigger DR1 Recorder	Trigger DR1 Recorder			
40,391		DR1 Recorder Active	DR1 Recorder Active			
40,392		DR2 Recorder Started	DR2 Recorder Started			
40,393		DR2 Recorder Completed	DR2 Recorder Completed			
40,394		DR2 Recorder Memory Low	DR2 Recorder Memory Low			
40,395		Trigger DR2 Recorder	Trigger DR2 Recorder			
40,396		DR2 Recorder Active	DR2 Recorder Active			
40,397		Any Recorder Started	Any Recorder Started			
40,398		Any Recorder Completed	Any Recorder Completed			
40,399		Any Recorder Memory Low	Any Recorder Memory Low			
40,400		Any Recorder Active	Any Recorder Active			
40,401		Reserved (returns 0)	Reserved (returns 0)			
40,402		Reserved (returns 0)	Reserved (returns 0)			
40,403		Reserved (returns 0)	Reserved (returns 0)			
40,404		Reserved (returns 0)	Reserved (returns 0)			
40,405		Reserved (returns 0)	Reserved (returns 0)			
40,406		Reserved (returns 0)	Reserved (returns 0)			
40,407		Reserved (returns 0)	Reserved (returns 0)			
40,408		Reserved (returns 0)	Reserved (returns 0)			
40,409		Reserved (returns 0)	Reserved (returns 0)			
40,410		Reserved (returns 0)	Reserved (returns 0)			
40,411		RMS Volts A 1	RMS Volts A 1			
40,412		RMS Volts B 1	RMS Volts B 1			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,413		RMS Volts C 1	RMS Volts C 1			
40,414		Phase Angle RMS Volts A 1 Harmonic 01	Phase Angle RMS Volts A 1 Harmonic 01			
40,415		Phase Angle RMS Volts B 1 Harmonic 01	Phase Angle RMS Volts B 1 Harmonic 01			
40,416		Phase Angle RMS Volts C 1 Harmonic 01	Phase Angle RMS Volts C 1 Harmonic 01			
40,417		RMS Amps A 1	RMS Amps A 1			
40,418		RMS Amps B 1	RMS Amps B 1			
40,419		RMS Amps C 1	RMS Amps C 1			
40,420		RMS Amps N 1	RMS Amps N 1			
40,421		Phase Angle RMS Amps A 1 Harmonic 01	Phase Angle RMS Amps A 1 Harmonic 01			
40,422		Phase Angle RMS Amps B 1 Harmonic 01	Phase Angle RMS Amps B 1 Harmonic 01			
40,423		Phase Angle RMS Amps C 1 Harmonic 01	Phase Angle RMS Amps C 1 Harmonic 01			
40,424		Phase Angle RMS Amps N 1 Harmonic 01	Phase Angle RMS Amps N 1 Harmonic 01			
40,425		RMS Volts A 2	RMS Volts A 2			
40,426		RMS Volts B 2	RMS Volts B 2			
40,427		RMS Volts C 2	RMS Volts C 2			
40,428		Phase Angle RMS Volts A 2 Harmonic 01	Phase Angle RMS Volts A 2 Harmonic 01			
40,429		Phase Angle RMS Volts B 2 Harmonic 01	Phase Angle RMS Volts B 2 Harmonic 01			
40,430		Phase Angle RMS Volts C 2 Harmonic 01	Phase Angle RMS Volts C 2 Harmonic 01			
40,431		RMS Amps A 2	RMS Amps A 2			
40,432		RMS Amps B 2	RMS Amps B 2			
40,433		RMS Amps C 2	RMS Amps C 2			
40,434		Reserved for RMS Amps N 2	Reserved for RMS Amps N 2			
40,435		Phase Angle RMS Amps A 2 Harmonic 01	Phase Angle RMS Amps A 2 Harmonic 01			
40,436		Phase Angle RMS Amps B 2 Harmonic 01	Phase Angle RMS Amps B 2 Harmonic 01			
40,437		Phase Angle RMS Amps C 2 Harmonic 01	Phase Angle RMS Amps C 2 Harmonic 01			
40,438		Reserved Phase Angle RMS Amps N 2 Harmoni 01	Reserved Phase Angle RMS Amps N 2 Harmoni 01			
40,439		Reserved (returns 0)	Reserved (returns 0)			
40,440		Reserved (returns 0)	Reserved (returns 0)			
40,441		Reserved (returns 0)	Reserved (returns 0)			
40,442		Reserved (returns 0)	Reserved (returns 0)			
40,443		Reserved (returns 0)	Reserved (returns 0)			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,444		Reserved (returns 0)	Reserved (returns 0)			
40,445		Reserved (returns 0)	Reserved (returns 0)			
40,446		Reserved (returns 0)	Reserved (returns 0)			
40,447		Reserved (returns 0)	Reserved (returns 0)			
40,448		Reserved (returns 0)	Reserved (returns 0)			
40,449		Reserved (returns 0)	Reserved (returns 0)			
40,450		Reserved (returns 0)	Reserved (returns 0)			
40,451		Virtual Status Input 1	Virtual Status Input 1			
40,452		Virtual Status Input 2	Virtual Status Input 2			
40,453		Virtual Status Input 3	Virtual Status Input 3			
40,454		Virtual Status Input 4	Virtual Status Input 4			
40,455		Virtual Status Input 5	Virtual Status Input 5			
40,456		Virtual Status Input 6	Virtual Status Input 6			
40,457		Virtual Status Input 7	Virtual Status Input 7			
40,458		Virtual Status Input 8	Virtual Status Input 8			
40,459		Virtual Status Input 9	Virtual Status Input 9			
40,460		Virtual Status Input 10	Virtual Status Input 10			
40,461		Virtual Status Input 11	Virtual Status Input 11			
40,462		Virtual Status Input 12	Virtual Status Input 12			
40,463		Virtual Status Input 13	Virtual Status Input 13			
40,464		Virtual Status Input 14	Virtual Status Input 14			
40,465		Virtual Status Input 15	Virtual Status Input 15			
40,466		Virtual Status Input 16	Virtual Status Input 16			
40,467		Virtual Status Input 17	Virtual Status Input 17			
40,468		Virtual Status Input 18	Virtual Status Input 18			
40,469		Virtual Status Input 19	Virtual Status Input 19			
40,470		Virtual Status Input 20	Virtual Status Input 20			
40,471		Virtual Status Input 21	Virtual Status Input 21			
40,472		Virtual Status Input 22	Virtual Status Input 22			
40,473		Virtual Status Input 23	Virtual Status Input 23			
40,474		Virtual Status Input 24	Virtual Status Input 24			
40,475		Virtual Status Input 25	Virtual Status Input 25			
40,476		Virtual Status Input 26	Virtual Status Input 26			
40,477		Virtual Status Input 27	Virtual Status Input 27			
40,478		Virtual Status Input 28	Virtual Status Input 28			
40,479		Virtual Status Input 29	Virtual Status Input 29			
40,480		Virtual Status Input 30	Virtual Status Input 30			
40,481		Virtual Status Input 31	Virtual Status Input 31			
40,482		Virtual Status Input 32	Virtual Status Input 32			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,483		Virtual Status Output Point 1	Virtual Status Output Point 1			
40,484		Virtual Status Output Point 2	Virtual Status Output Point 2			
40,485		Virtual Status Output Point 3	Virtual Status Output Point 3			
40,486		Virtual Status Output Point 4	Virtual Status Output Point 4			
40,487		Virtual Status Output Point 5	Virtual Status Output Point 5			
40,488		Virtual Status Output Point 6	Virtual Status Output Point 6			
40,489		Virtual Status Output Point 7	Virtual Status Output Point 7			
40,490		Virtual Status Output Point 8	Virtual Status Output Point 8			
40,491		Virtual Status Output Point 9	Virtual Status Output Point 9			
40,492		Virtual Status Output Point 10	Virtual Status Output Point 10			
40,493		Virtual Status Output Point 11	Virtual Status Output Point 11			
40,494		Virtual Status Output Point 12	Virtual Status Output Point 12			
40,495		Virtual Status Output Point 13	Virtual Status Output Point 13			
40,496		Virtual Status Output Point 14	Virtual Status Output Point 14			
40,497		Virtual Status Output Point 15	Virtual Status Output Point 15			
40,498		Virtual Status Output Point 16	Virtual Status Output Point 16			
40,499		Virtual Status Output Point 17	Virtual Status Output Point 17			
40,500		Virtual Status Output Point 18	Virtual Status Output Point 18			
40,501		Virtual Status Output Point 19	Virtual Status Output Point 19			
40,502		Virtual Status Output Point 20	Virtual Status Output Point 20			
40,503		Virtual Status Output Point 21	Virtual Status Output Point 21			
40,504		Virtual Status Output Point 22	Virtual Status Output Point 22			
40,505		Virtual Status Output Point 23	Virtual Status Output Point 23			
40,506		Virtual Status Output Point 24	Virtual Status Output Point 24			
40,507		Virtual Status Output Point 25	Virtual Status Output Point 25			
40,508		Virtual Status Output Point 26	Virtual Status Output Point 26			
40,509		Virtual Status Output Point 27	Virtual Status Output Point 27			
40,510		Virtual Status Output Point 28	Virtual Status Output Point 28			
40,511		Virtual Status Output Point 29	Virtual Status Output Point 29			
40,512		Virtual Status Output Point 30	Virtual Status Output Point 30			
40,513		Virtual Status Output Point 31	Virtual Status Output Point 31			
40,514		Virtual Status Output Point 32	Virtual Status Output Point 32			
40,515		Reserved (returns 0)	Reserved (returns 0)			
40,516		Reserved (returns 0)	Reserved (returns 0)			
40,517		Reserved (returns 0)	Reserved (returns 0)			
40,518		Reserved (returns 0)	Reserved (returns 0)			
40,519		Reserved (returns 0)	Reserved (returns 0)			
40,520		Reserved (returns 0)	Reserved (returns 0)			
40,521		Reserved (returns 0)	Reserved (returns 0)			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,522		Reserved (returns 0)	Reserved (returns 0)			
40,523		Reserved (returns 0)	Reserved (returns 0)			
40,524		Reserved (returns 0)	Reserved (returns 0)			
40,525		Reserved (returns 0)	Reserved (returns 0)			
40,526		Reserved (returns 0)	Reserved (returns 0)			
40,527		Reserved (returns 0)	Reserved (returns 0)			
40,528		Reserved (returns 0)	Reserved (returns 0)			
40,529		Reserved (returns 0)	Reserved (returns 0)			
40,530		Reserved (returns 0)	Reserved (returns 0)			
40,531		Impedance A 1	Impedance A 1			
40,532		Impedance B 1	Impedance B 1			
40,533		Impedance C 1	Impedance C 1			
40,534		Resistance A 1	Resistance A 1			
40,535		Resistance B 1	Resistance B 1			
40,536		Resistance C 1	Resistance C 1			
40,537		Reactance A 1	Reactance A 1			
40,538		Reactance B 1	Reactance B 1			
40,539		Reactance C 1	Reactance C 1			
40,540		Phase Angle A Volts - Amps 1	Phase Angle A Volts - Amps 1			
40,541		Phase Angle B Volts - Amps 1	Phase Angle B Volts - Amps 1			
40,542		Phase Angle C Volts - Amps 1	Phase Angle C Volts - Amps 1			
40,543		Impedance A 2	Impedance A 2			
40,544		Impedance B 2	Impedance B 2			
40,545		Impedance C 2	Impedance C 2			
40,546		Resistance A 2	Resistance A 2			
40,547		Resistance B 2	Resistance B 2			
40,548		Resistance C 2	Resistance C 2			
40,549		Reactance A 2	Reactance A 2			
40,550		Reactance B 2	Reactance B 2			
40,551		Reactance C 2	Reactance C 2			
40,552		Phase Angle A Volts - Amps 2	Phase Angle A Volts - Amps 2			
40,553		Phase Angle B Volts - Amps 2	Phase Angle B Volts - Amps 2			
40,554		Phase Angle C Volts - Amps 2	Phase Angle C Volts - Amps 2			
40,555		Reserved (returns 0)	Reserved (returns 0)			
40,556		Reserved (returns 0)	Reserved (returns 0)			
40,557		Reserved (returns 0)	Reserved (returns 0)			
40,558		Reserved (returns 0)	Reserved (returns 0)			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,559		Reserved (returns 0)	Reserved (returns 0)			
40,560		Reserved (returns 0)	Reserved (returns 0)			
40,561		Reserved (returns 0)	Reserved (returns 0)			
40,562		Reserved (returns 0)	Reserved (returns 0)			
40,563		Reserved (returns 0)	Reserved (returns 0)			
40,564		Reserved (returns 0)	Reserved (returns 0)			
40,565		Reserved (returns 0)	Reserved (returns 0)			
40,566		Reserved (returns 0)	Reserved (returns 0)			
40,567		Reserved (returns 0)	Reserved (returns 0)			
40,568		Reserved (returns 0)	Reserved (returns 0)			
40,569		Reserved (returns 0)	Reserved (returns 0)			
40,570		Reserved (returns 0)	Reserved (returns 0)			
40,571		Reserved (returns 0)	Reserved (returns 0)			
40,572		TI#1 Input 1	TI#1 Input 1			
40,573		TI#1 Input 2	TI#1 Input 2			
40,574		TI#1 Input 3	TI#1 Input 3			
40,575		TI#1 Input 4	TI#1 Input 4			
40,576		TI#1 Input 5	TI#1 Input 5			
40,577		TI#1 Input 6	TI#1 Input 6			
40,578		TI#1 Input 7	TI#1 Input 7			
40,579		TI#1 Input 8	TI#1 Input 8			
40,580		TI#2 Input 1	TI#2 Input 1			
40,581		TI#2 Input 2	TI#2 Input 2			
40,582		TI#2 Input 3	TI#2 Input 3			
40,583		TI#2 Input 4	TI#2 Input 4			
40,584		TI#2 Input 5	TI#2 Input 5			
40,585		TI#2 Input 6	TI#2 Input 6			
40,586		TI#2 Input 7	TI#2 Input 7			
40,587		TI#2 Input 8	TI#2 Input 8			
40,588		TI#3 Input 1	TI#3 Input 1			
40,589		TI#3 Input 2	TI#3 Input 2			
40,590		TI#3 Input 3	TI#3 Input 3			
40,591		TI#3 Input 4	TI#3 Input 4			
40,592		TI#3 Input 5	TI#3 Input 5			
40,593		TI#3 Input 6	TI#3 Input 6			
40,594		TI#3 Input 7	TI#3 Input 7			
40,595		TI#3 Input 8	TI#3 Input 8			
40,596		TI#4 Input 1	TI#4 Input 1			
40,597		TI#4 Input 2	TI#4 Input 2			
40,598		TI#4 Input 3	TI#4 Input 3			
40,599		TI#4 Input 4	TI#4 Input 4			
40,600		TI#4 Input 5	TI#4 Input 5			
40,601		TI#4 Input 6	TI#4 Input 6			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,602		TI#4 Input 7	TI#4 Input 7			
40,603		TI#4 Input 8	TI#4 Input 8			
40,604		TI#5 Input 1	TI#5 Input 1			
40,605		TI#5 Input 2	TI#5 Input 2			
40,606		TI#5 Input 3	TI#5 Input 3			
40,607		TI#5 Input 4	TI#5 Input 4			
40,608		TI#5 Input 5	TI#5 Input 5			
40,609		TI#5 Input 6	TI#5 Input 6			
40,610		TI#5 Input 7	TI#5 Input 7			
40,611		TI#5 Input 8	TI#5 Input 8			
40,612		TI#6 Input 1	TI#6 Input 1			
40,613		TI#6 Input 2	TI#6 Input 2			
40,614		TI#6 Input 3	TI#6 Input 3			
40,615		TI#6 Input 4	TI#6 Input 4			
40,616		TI#6 Input 5	TI#6 Input 5			
40,617		TI#6 Input 6	TI#6 Input 6			
40,618		TI#6 Input 7	TI#6 Input 7			
40,619		TI#6 Input 8	TI#6 Input 8			
40,620		TI#7 Input 1	TI#7 Input 1			
40,621		TI#7 Input 2	TI#7 Input 2			
40,622		TI#7 Input 3	TI#7 Input 3			
40,623		TI#7 Input 4	TI#7 Input 4			
40,624		TI#7 Input 5	TI#7 Input 5			
40,625		TI#7 Input 6	TI#7 Input 6			
40,626		TI#7 Input 7	TI#7 Input 7			
40,627		TI#7 Input 8	TI#7 Input 8			
40,628		Reserved (returns 0)	Reserved (returns 0)			
40,629		Reserved (returns 0)	Reserved (returns 0)			
40,630		Reserved (returns 0)	Reserved (returns 0)			
40,631		Reserved (returns 0)	Reserved (returns 0)			
40,632		Reserved (returns 0)	Reserved (returns 0)			
40,633		Reserved (returns 0)	Reserved (returns 0)			
40,634		Reserved (returns 0)	Reserved (returns 0)			
40,635		Reserved (returns 0)	Reserved (returns 0)			
40,636		Reserved (returns 0)	Reserved (returns 0)			
40,637		Reserved (returns 0)	Reserved (returns 0)			
40,638		Reserved (returns 0)	Reserved (returns 0)			
40,639		Reserved (returns 0)	Reserved (returns 0)			
40,640		Reserved (returns 0)	Reserved (returns 0)			
40,641			RMS Volts A 1 Harmonic 00			
40,642			RMS Volts B 1 Harmonic 00			
40,643			RMS Volts C 1 Harmonic 00			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,644			RMS Volts AB 1 Harmonic 00			
40,645			RMS Volts BC 1 Harmonic 00			
40,646			RMS Volts CA 1 Harmonic 00			
40,647			RMS Amps A 1 Harmonic 00			
40,648			RMS Amps B 1 Harmonic 00			
40,649			RMS Amps C 1 Harmonic 00			
40,650			RMS Amps N 1 Harmonic 00			
40,651			RMS Volts A 2 Harmonic 00			
40,652			RMS Volts B 2 Harmonic 00			
40,653			RMS Volts C 2 Harmonic 00			
40,654			RMS Volts AB 2 Harmonic 00			
40,655			RMS Volts BC 2 Harmonic 00			
40,656			RMS Volts CA 2 Harmonic 00			
40,657			RMS Amps A 2 Harmonic 00			
40,658			RMS Amps B 2 Harmonic 00			
40,659			RMS Amps C 2 Harmonic 00			
40,660			Reserved for RMS Amps N 2 Harmonic 00			
40,661			Phase Angle RMS Volts A 1 Harmonic 00			
40,662			Phase Angle RMS Volts B 1 Harmonic 00			
40,663			Phase Angle RMS Volts C 1 Harmonic 00			
40,664			Phase Angle RMS Volts AB 1 Harmonic 00			
40,665			Phase Angle RMS Volts BC 1 Harmonic 00			
40,666			Phase Angle RMS Volts CA 1 Harmonic 00			
40,667			Phase Angle RMS Amps A 1 Harmonic 00			
40,668			Phase Angle RMS Amps B 1 Harmonic 00			
40,669			Phase Angle RMS Amps C 1 Harmonic 00			
40,670			Phase Angle RMS Amps N 1 Harmonic 00			
40,671			Phase Angle RMS Volts A 2 Harmonic 00			
40,672			Phase Angle RMS Volts B 2 Harmonic 00			
40,673			Phase Angle RMS Volts C 2 Harmonic 00			

Modbus Address	BLF Bitronics Legacy Fixed	BAF Bitronics Advanced Fixed	HAF Harmonic Advanced Fixed	SFC Single Feeder Configurable	DFC Dual Feeder Configurable	TUC Totally User Configurable
40,674			Phase Angle RMS Volts AB 2 Harmonic 00			
40,675			Phase Angle RMS Volts BC 2 Harmonic 00			
40,676			Phase Angle RMS Volts CA 2 Harmonic 00			
40,677			Phase Angle RMS Amps A 2 Harmonic 00			
40,678			Phase Angle RMS Amps B 2 Harmonic 00			
40,679			Phase Angle RMS Amps C 2 Harmonic 00			
40,680			Reserved (returns 0)			
40,681			Reserved (returns 0)			
40,682			Reserved (returns 0)			
40,683			Reserved (returns 0)			
40,684			Reserved (returns 0)			
40,685			Reserved (returns 0)			
			Repeats harmonic values listed above for remaining harmonics through register 43525			

Revision	Date	Changes	By
A	01/30/2009	Update Bitronics Name, Logo	E. Demicco
B	05/01/09	Updated logos and cover page	MarCom
C	9/18/09	Time Sync features: Added 1.7.1 & 1.7.2; Updated Appendix B with new Register assignments for 40305, 40306, 40308 in BAF & HAF. Renamed Registers 40303 & 40404.	R. Fisher

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